PROJECT MANUAL

NILAND COUNTY SANITATION DISTRICT –
WASTEWATER TREATMENT PLANT AND COLLECTION SYSTEM IMPROVEMENTS
COUNTY PROJECT NO. 6582NSD

September 25, 2023

Funded by:
North American Development (NAD) Bank No. ??

California Department of Housing and Community Development (HCD)
Through Its Community Development Block Grant (CDBG) Program
HCD Project No. SR49337
CDBG Grant No. 20-CDBG-12086

United States Department of Agriculture (USDA) Rural Development
USDA No. ??

Prepared by:
The Holt Group, Inc.
THG Project No. 542.089

For:
Imperial County Public Works Department
155 South 11th Street
El Centro, CA 92243
Point of Contatct: David Dale
Office: (442) 265-1818

REGISTERED PROFESSIONAL ENGINEER
JAMES G. HOLT
No. 31773
Exp. 12-31-24
CIVIL
STATE OF CALIFORNIA

VOLUME 3 OF 5

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SECTION 01520 - TEMPORARY FACILITIES

PART 1 - GENERAL

1.01 DESCRIPTION

The Owner shall bear no costs of temporary facilities, unless noted otherwise.

It shall be the Contractor's responsibility to provide equipment that is adequate for the performance of the Work under this Contract within the time specified. All equipment shall be kept in satisfactory operating condition, shall be capable of safely and efficiently performing the required Work and shall be subject to inspection and approval by the Owner's representative at any time within the duration of the Contract. All work hereunder shall conform to the applicable requirements of the OSHA Standards for Construction.

1.02 POWER AND LIGHTING

The Contractor shall provide temporary electric power as necessary for the execution of the Work, including that required by all Subcontractors. Contractor shall make the necessary arrangements with utility purveyor to include all permits, applications and fees, and shall bear all costs for these temporary services and shall furnish and install all necessary transformers, metering facilities and distribution centers from branch circuits as may be required.

The Contractor shall provide lighting and outlets in temporary structures throughout the Project as may be required for safety, proper performance and inspection of the Work. If operations are performed during hours of darkness, or if natural lighting is deemed insufficient by Engineer, the Contractor shall provide adequate floodlights, clusters and spot illumination. The use of permanently installed lighting fixtures, lamps and tubes for work shall not be permitted except by special permission of Engineer. The Contractor shall make arrangements with Subcontractors for electrical services and lighting as may be necessary in the performance of their work.

1.03 WATER SUPPLY

A. General: The Contractor shall provide an adequate supply of water of a quality suitable for all potable, domestic, and construction purposes.

B. Drinking Water: All drinking water on the site during construction shall be furnished by the Contractor and shall be bottled water or water furnished in approved dispensers. Notices shall be posted conspicuously throughout the site warning the Contractor's personnel that piped water for construction purposes may be contaminated and is not for human consumption.

C. Water Connections: The Contractor shall not make connection to, or draw water from, any fire hydrant or pipeline without first obtaining permission, in writing, of the authority having jurisdiction over the use of said fire hydrant or pipeline and from the agency owning the water system. For each such connection made the Contractor shall first attach to the fire hydrant or pipeline a valve, backflow preventer and a meter, if required by the said authority, of a size and type acceptable to said authority and agency.

D. Removal of Water Connections: Before final acceptance of the Work all temporary water connections and piping installed by the Contractor shall be entirely removed, and all affected improvements shall be restored to their original condition, or better, to the satisfaction of the Engineer and to the agency owning the affected utility.

E. Fire Protection: The Contractor shall provide fire extinguishers and other fire protection equipment to adequately protect new and existing facilities and temporary facilities

against damage by fire. Hose connections and hose, water casks, chemical equipment or other sufficient means shall be provided for fighting fires in the new, existing and temporary structures and other portions of the Work and responsible persons shall be designated and instructed in the operation of such fire apparatus so as to prevent or minimize the hazard of fire. The Contractor's fire protection program shall conform to the requirements of the OSHA Standards for Construction. The Contractor shall employ every reasonable means to prevent the hazard of fire.

1.04 CONSTRUCTION OFFICE TRAILER

Not Applicable

1.05 SANITATION

A. Toilet Facilities: Portable chemical toilet facilities shall be provided wherever needed for the use of employees. Toilets at Site(s) shall conform to the requirements of Subpart "D", Section 1926.51 of the OSHA Standards for Construction. The Owner's toilet facilities shall not be used by the Contractor. Two (2) toilet facilities shall be positioned at the project site. One (1) toilet facility shall be for men. The other toilet facility shall be for women. Toilet facilities shall be relocated as required and be maintained close to daily work activities. The toilet facilities shall be cleaned and serviced on a weekly basis.

B. Sanitary and Other Organic Wastes: The Contractor shall establish adequate and regular collection of all sanitary and organic wastes. All wastes and refuse from sanitary facilities provided by the Contractor or organic material wastes from any other source related to the Contractor's operations shall be disposed of in a manner satisfactory to the Engineer and in accordance with all laws and regulations pertaining thereto. Contractor may install temporary piping for toilet facilities to discharge into the incoming sewer.

1.06 COMMUNICATIONS

A. Telephone Services: The Contractor shall provide and maintain a phone line.

1.07 FENCE AND BARRICADES

The Contractor shall provide such protective fences and barricades as deemed necessary for public safety and to protect storage areas and the Work in place. The location and appearance of all fences shall be subject to the approval of the Engineer.

1.08 CONTRACTOR PARKING

The Contractor shall not park his equipment, nor allow his personnel to park, in any area except those specifically designated by the Engineer and Owner.

1.09 TEMPORARY LIVING QUARTERS

Temporary living quarters shall not be allowed on the Site or on publicly owned properties. In addition, all local zoning codes for the area in question shall be strictly adhered to.

1.10 REMOVAL OF TEMPORARY CONSTRUCTION FACILITIES

The Contractor shall remove temporary toilets, storage sheds and other temporary construction facilities from the site as soon as, in Engineer's opinion, the progress of Work permits. Contractor shall recondition and restore those portions of the site occupied by the same to a condition equal to or better than it was prior to construction.

END OF SECTION

SECTION 01530 - PROTECTION OF EXISTING FACILITIES

PART 1 - GENERAL

1.01 DESCRIPTION

A. The Contractor shall protect all existing utilities, piping and improvements not designated for removal and shall restore damaged or temporarily relocated utilities, piping and improvements to a condition equal to or better than they were prior to such damage or temporary relocation.

B. The Contractor shall verify the exact locations and depths of all underground piping and utilities shown and not shown and shall make exploratory excavations of all piping and utilities that may interfere with the Work. It shall be the Contractor's responsibility to ascertain the actual location of all existing utilities, piping and other improvements that will be encountered during construction operations and verify that such utilities or other improvements are adequately protected from damage due to such operations.

C. Maintaining in Service: All pipelines, electrical, power, telephone communication cables, gas and water mains shall remain continuously in service during all the operations under the Contract, unless other arrangements satisfactory to the Engineer are made with the Owner. Where the proper completion of the Work requires the temporary or permanent removal and/or relocation of an existing utility or other improvement the Contractor, after necessary scheduling and approval, shall remove and, without unnecessary delay, temporarily replace or relocate such utility or improvement in a manner satisfactory to the Engineer and the Owner of the facility. In all cases of such temporary removal or relocation, the Work shall be accomplished by the Contractor in a manner that will restore or replace the utility or improvement to a new condition meeting the specification requirements.

D. All repairs to a damaged utility or improvement are subject to inspection and approval by a Resident Project Representative before being concealed by backfill or other work.

1.02 RIGHTS-OF-WAY

A. The Contractor shall refrain from commencing work or entering upon the rights-of-way of any oil, gas, sewer or water pipeline; any telephone or electric transmission line; any fence; or any other structure, until notified by the Engineer that the Owner has secured authority to do so. After authority has been obtained, the Contractor shall give the governing utility proper advanced notice of its intention to begin work.

1.03 RESTORATION OF PAVEMENT AND SIDEWALKS

A. All paved areas and sidewalks not designated for replacement, cut or damaged during construction shall be replaced with similar materials and of equal thickness to match the existing adjacent undisturbed areas unless otherwise noted. All sidewalks, curbs and gutters and pavements which are subject to partial removal shall be neatly saw-cut in straight lines. The sidewalk, curb and gutter and pavement shall be constructed in accordance with the Standard Details and Plans of the governing agency.

1.04 UNDERGROUND UTILITIES NOT SHOWN OR INDICATED

A. If the Contractor damages existing utilities, piping or improvements that are not illustrated or the location of which was not made known to the Contractor prior to excavation and the damage was not due to failure of the Contractor to exercise reasonable care the Contractor shall immediately notify the Engineer. If directed by the Engineer

repairs shall be made by the Contractor under the provisions for changes and extra work contained in the Standard General Conditions.

The Contractor is responsible for notification to California Underground Service Alert (Dig Alert) to identify and locate existing utilities within the project area. Dig Alert must be notified a minimum of two working days prior to the commencement of any digging or excavation.

1.05 NOTIFICATION BY THE CONTRACTOR

A. Prior to any excavation in the vicinity of any existing underground facilities, including water, sewer, storm drain, gas, petroleum products, or other pipelines; all buried electric power, communications or telecommunication cables; all traffic signal and street lighting facilities; and all roadway and state highway rights-of-way, the Contractor shall notify the respective utility purveyors or agencies or owners responsible for such facilities not less than three (3) working days prior to excavation so that a representative is afforded the opportunity to be present during the excavation work.

END OF SECTION

SECTION 01550 - SITE ACCESS AND STORAGE

PART 1 - GENERAL

1.01 HIGHWAY AND STREET LIMITATIONS

A. The Contractor shall make its own investigation of the condition of available public and private roads and of clearances, restrictions, bridge load limits and other limitations affecting transportation and ingress and egress to the Site. It shall be the Contractor's responsibility to construct and maintain any haul roads required for its construction operations or define any alternate routes to the Site due to roadway or bridge restrictions.

B. Nothing herein shall be construed to entitle the Contractor to the exclusive use of any public street, utility right-of-way or the Site during the performance of the Work hereunder. The Contractor shall conduct its operations so as not to interfere unnecessarily with the authorized work of utility companies, other agencies, or the Owner's personnel. No street or access shall be closed without first obtaining permission of the Engineer or proper governmental authority. Where excavation is being performed in primary streets or highways one (1) lane in each direction shall be kept open to traffic at all times unless otherwise provided or shown by the Contract Documents. Fire hydrants on or adjacent to the Work shall be kept accessible to fire-fighting equipment at all times. Temporary provisions shall be made by the Contractor to assure the use of sidewalks, access routes and the proper functioning of all gutters, sewer inlets and other drainage facilities.

C. Traffic Control: For the protection of traffic in public streets and construction workers at the Site, the Contractor shall provide, place and maintain all necessary barricades, traffic cones, warning signs, lights and other approved safety devices. All barricades, traffic cones, warning signs, lights and other approved safety devices shall be placed according to the agency requirements maintaining jurisdiction, as applicable. The Contractor shall take all necessary precautions for the protection of the Work and the safety of the Owner's personnel and the public. All barricades and obstructions shall be illuminated at night.

1.02 CONTRACTOR'S WORK AND STAGING AREA

A. The Owner will designate and arrange, for the Contractor's use, a portion(s) of the property on or adjacent to the Site for its exclusive use during the term of the Contract. The area is designated for an office, storage and shop area for construction operations relative to this Contract. The Contractor shall be solely responsible for the security of its tools, supplies and equipment at the site.

END OF SECTION

SECTION 01560 - PROJECT ENVIRONMENTAL CONTROLS

PART 1 - GENERAL

1.01 EXPLOSIVES AND BLASTING

A. The use or storage of explosives on the Work or site will not be permitted.

B. If applicable, controls outlined in the Environmental Report developed for this project shall be implemented throughout the course of construction. A copy of the Environmental Report is included in the Special Conditions, if any.

1.02 DUST ABATEMENT AND RUBBISH CONTROL

A. The Contractor shall provide under the Contract all necessary measures to prevent its operation from producing dust in amounts damaging to property or causing a nuisance to Owner's personnel and operations or to persons living in or occupying buildings in the vicinity. The Contractor shall be responsible for damage resulting from any dust originating from its operations. The dust abatement measures shall be continued throughout the length of the Contract.

B. During the progress of the Work the Contractor shall keep the Site and other areas used by it in a neat and clean condition and free from any accumulation of rubbish and waste materials. The Contractor shall dispose of all rubbish and waste materials of any nature occurring at the Site, and shall establish regular intervals of collection and disposal of such materials and waste. The Contractor shall also keep its haul roads free from dirt, rubbish and unnecessary obstructions resulting from its operations. Disposal of all rubbish and surplus materials shall be off the site of construction in accordance with local codes and ordinances governing locations and methods of disposal and in conformance with all applicable Safety Laws and Health Standards for Construction. The Owner's dumpster shall not be used by the Contractor.

C. Contractor shall implement regulations set by CAL EPA and the Imperial County Air Pollution Control District for all work activities related to this Project.

1.03 CHEMICALS

A. All chemicals used during project construction or furnished for project operation, whether soil sterilant, herbicide, pesticide, disinfectant, polymer, reactant or of other classification, shall show approval for use by either the U.S. Environmental Protection Agency, the U.S. Department of Agriculture or the local jurisdictional agency. Use of all such chemicals and disposal of residues shall be in strict accordance with the printed instructions of the manufacturer.

1.04 CULTURAL RESOURCES

A. The Contractor's attention is directed to the National Historic Preservation Act of 1966 (16 U.S.C. 470) and 36 CFR 800 which provides for the preservation of potential historical, architectural, archeological or cultural resources (hereinafter called "cultural resources). If potential cultural resources are discovered during subsurface excavations at the site of construction, the following procedures shall be instituted:

1. The Contractor shall immediately notify the Engineer.

2. The Engineer will issue a Field Order directing the Contractor to cease all construction operations at the location of such potential cultural resources find.

3. Such Field Order shall be effective until such time as a qualified archeologist can be called to assess the value of these potential cultural resources and make recommendations to the California State Historical Society Archeologist.

B. If the archeologist determines that the potential find is a bona fide cultural resource, at the direction of the California State Historical Society Archeologist, the Contractor shall suspend work at the location of the find under the provisions for changes contained in Articles 4, 8 and 18 of the Standard General Conditions and Supplementary Conditions 4.02, 4.06 and 4.06D.

1.05 STORM WATER POLLUTION PREVENTION PLAN (SWPPP)

A. The soil disturbance area resulted by the construction of the project will be less than 1 acre, therefore, the project is exempt from completing Storm Water Pollution Prevention Plan (SWPPP).

END OF SECTION

SECTION 01600 - MATERIALS AND EQUIPMENT

PART 1 - GENERAL

1.01 QUALITY ASSURANCE

A. To the greatest extent possible for each unit of work, the Contractor shall provide products, materials or equipment from a single source.

B. Where more than one choice is available as options for Contractor's selection of a product, material or equipment, the Contractor shall select an option which is compatible with other products, materials or equipment already selected.

1.02 PRODUCT DELIVERY, STORAGE AND HANDLING

A. The Contractor shall transport, deliver, handle and store products in accordance with supplier's written recommendations and by methods and means which will prevent damage, deterioration and loss including theft. Delivery schedules shall be coordinated to minimize long-term storage of products at the Site and overcrowding of construction spaces. The Contractor shall provide installation coordination to ensure minimum storage times for products recognized to be flammable, hazardous or easily damaged.

B. Products shall be delivered in a dry, undamaged condition in the supplier's unopened packaging. The Engineer and Owner reserve the right to reject all damaged products, materials and equipment. Rejected products shall be immediately removed from the Site.

C. Products, materials and equipment shall be stored in accordance with the manufacturer's written instructions, with seals and labels intact and legible. Motors, electrical gear, mechanical equipment with open bearings or moving parts or any product sensitive to the environment shall be stored in weather-tight enclosures with necessary temperature and humidity ranges maintained within the manufacturer's instructions.

D. Fabricated structural components shall be stored on supports above ground and in a manner to prevent accumulation of water and warping. Products subject to deterioration from atmospheric conditions shall be covered in a manner that will provide adequate ventilation to avoid condensation.

E. Products, materials and equipment not stored in a manner that will insure the maintaining of a new condition will be rejected by the Engineer. Such rejected products, materials and equipment shall be immediately removed from the Site.

END OF SECTION 01600

SECTION 01660 - MECHANICAL EQUIPMENT - INSTALLATION AND START-UP

PART 1 - GENERAL

1.01 DESCRIPTION

A. This section contains general information required for the installation of mechanical equipment as specified within the various individual specifications. The plans and/or performance specifications describe equipment and general layout based on certain commercially available equipment. It shall be the responsibility of the Contractor to ascertain the compatibility of all equipment and utilization of available space based on the Contractor's approved design and/or shop drawings and intent of these Contract Documents.

B. Included shall be all supervision, labor, materials, tools, equipment and services as required for the furnishing, installation, testing and operation of equipment including the services of manufacturer service engineers, receiving, unloading, storage, protection, installation and complete erection of all mechanical equipment required in these Contract Documents.

C. Installation shall include, but not be limited to placing, core drilling, shimming, anchoring, grouting, cleaning, painting, lubricating, assembling, testing and adjusting of all mechanical equipment. Installation shall also include providing all required miscellaneous parts and appurtenances.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 15380 – Motors

1.03 DESCRIPTION

A. General:

1. The Contractor shall be liable for all damage to the equipment which is to be furnished and installed under this Contract, as well as for any damage to the building structures, existing equipment or other property, real or personal, resulting from the movement of equipment or installation work. This liability shall continue until the installed equipment is accepted by the Owner.

2. The Contractor shall cause the equipment to be furnished under this division to be the product of firms regularly engaged in the design and manufacture of the type of item specified, possessing the required technical competence, skill, resources and ability to complete the work specified herein with the requisite degree of quality and in a timely and efficient manner. The Contractor shall be prepared to adequately document the qualification of the manufacturers nominated to provide equipment specified under this division. All documentation shall be submitted to the Owner or representative for review and acceptance prior to design, fabrication and shipment of any component specified herein. Nothing contained within these provisions shall be construed as relieving the Contractor of his responsibility for any portion of the work covered by this division.

B. Arrangement:

1. This arrangement of equipment as described by the specifications is based upon the best information available to the Owner at the time of the preparation of the concept drawings and specifications and is not intended to show exact dimensions peculiar to any specific manufacturer unless otherwise shown or specified. The Conceptual Drawings are, in part, diagrammatic, and, therefore, it is to be expected that the illustrated equipment, if any, be installed be per the Contractor's design and conform adequately to actual equipment installation requirements. The Owner or representative will review all equipment shope drawings, and installations to assure compliance with these requirements. It is to be anticipated that structural supports, equipment pads, foundations, connected piping and valves shown, in part or in whole, may have to be altered in order to accommodate the equipment furnished. Equipment pads shall be increased or reduced in size to properly suit the actual equipment. No additional payment will be made for such changes. All necessary calculations and drawings shall be submitted to the Owner or representative prior to beginning of the construction phase.

1.04 QUALITY ASSURANCE

A. Equipment and appurtenances shall be designed in conformity with the conceptual documents and performance specifications. Equipment shall be constructed of materials for the conditions of exposure and of such strength to withstand all stress which may occur during testing, installation, all conditions of operation, including start-up, shut-down and power failure.

B. All equipment shall be installed true and level and to the locations shown on the Plans. All work shall be performed to the satisfaction of the Owner. Precision gauges and levels shall be used in setting all equipment.

C. The Contractor shall be responsible for installation of the equipment in a manner consistent with the requirements of performance warranties and equipment workmanship of the manufacturer.

D. Machinery parts shall conform exactly to the dimensions shown on the Shop Drawings. The corresponding parts of identical machines shall be made interchangeable. Clearance shall be provided for repairs, inspection and adjustment.

E. Exposed surfaces shall be finished in appearance. All exposed welds shall be ground smooth at the corners for personnel protection.

F. All machinery and equipment shall comply in all respects with the provisions of the Occupational Safety and Health Act of 1970, and other applicable Federal, State and local laws and regulations.

G. Conformance to Design Criteria and Performance Guarantee.

1. In submitting a bid, the Contractor shall formally acknowledge receipt of and understanding of the design criteria presented in the Conceptual Drawings and Performance Specifications and guarantees that the equipment to be supplied shall be designed and performs in compliance with the design criteria.

2. Contractor shall guarantee all equipment provided under this Contract in accordance with the Contract Documents.

1.05 SUBMITTALS AND MISCELLANEOUS REQUIREMENTS

A. General:

1. All mechanical equipment provided under this division shall be submitted for review by the Owner or Representative. The submittal package for each individual equipment or groups of related equipment shall be complete and in accordance with Section 01300 – Submittals/Shop Drawings.

PART 2 - PRODUCTS

2.01 ANCHORS AND SUPPORTS

A. The Contractor shall furnish, install and protect all guides, bearing plates, anchor and attachment bolts, and all other appurtenances required for the installation of equipment. Anchors and supports shall be of ample size and strength for the purpose intended and shall be approved by the Owner or Representative.

B. Anchor bolts shall be furnished and set in concrete foundations where required. All anchor bolts, studs and fasteners shall be Class 316 stainless steel.

C. Anchor bolts, flange bolts, and other fasteners using nuts and threaded bolts shall have no more than 1 ½ to 2 threads extending beyond the nut when fully tightened.

D. The Contractor shall obtain and use shop drawings and suitable templates when required for installation of equipment.

2.02 LUBRICATION

A. The Contractor shall thoroughly lubricate all equipment in accordance with the equipment manufacturer's instructions. Lubricating oils and greases shall be of the type and viscosity recommended by the equipment manufacturer.

B. All lubricants shall be furnished with flushing oils as recommended by the manufacturer. This includes, but is not limited to, all gearing and bearings, regardless of whether they have been shipped with or without oil soluble protective coatings.

C. Following flushing, oil lubricating systems shall be filled with "run-in" oil as recommended by the equipment manufacturer. The equipment shall be "run-in" at the no load condition for a minimum of two (2) hours. Following "run-in" and inspection, the equipment is to be drained and flushed again with flushing oil and refilled with lubricant as recommended by the manufacturer.

D. The grease fittings on all mechanical equipment shall be such that they can be serviced with a single type of grease gun. Grease fittings shall be standard zirt type.

E. Where locally mounted grease fittings would be difficult to service, the fitting shall be extended by adequately sized 316 stainless steel tubing to a point that shall provide accessibility for normal maintenance. Such points shall be located and installed as per the Owner or Representative's directive.

2.03 PROTECTIVE COATING AND PAINTING

A. All equipment and materials shall be shop painted. Particular attention shall be directed to wetted surfaces and other areas exposed to corrosive, extreme temperature or other hazardous environments.

B. Painting shall be in strict accordance with Section 09800 unless otherwise indicated in the detailed equipment specifications. If there is no Section 09800, coating shall be as follows:

1. Ferrous Metals: Exterior Exposure (Non-submerged and non-buried)

a. Surface preparation: SSPC-SP 6.

b. Product: Devoe:

(1) Primer: Bar Rust 231 - 2 coats (3-5 mils DFT)

(2) Intermediate: Devran 224 HS (4-5 mils DFT)

(3) Finish: Devthane 378H - 1 coat (3-5 mils DFT) or approved equal.

c. Color to be selected by the Owner.

2. All Piping and Valves that have a factory epoxy coating shall receive a final coating in the field with a product compatible with the existing coating.

a. Color to be selected by the Owner.

C. All machined surfaces and shafting shall be cleaned and protected from corrosion by the proper type and amount of coating necessary to assure a minimum protection for two (2) years after shipment.

D. Oil lubricated gearing, bearings, and other lubricated components shall be shipped with an oil soluble protective coating as recommended by the manufacturer. The coating shall be selected to provide protection for two (2) years.

E. Motors, reducers and electric controls shall have the standard factory finish prior to delivery except where specific exception is noted in the individual equipment specifications.

F. Provide two (2) gallons of paint compatible with the equipment finish coat for field touch-up and provide blend numbers for primer coat and finish coat paints.

2.04 COUPLINGS

A. Unless otherwise specified, mechanical equipment with a driver greater than ½ horsepower, and where the input shaft of a driven unit is directly connected to the output shaft of the drive, shall have its two shafts connected by a flexible coupling which can accommodate angular misalignment, parallel misalignment and end float, and which cushions shock loads and dampens torsional vibrations. The flexible member shall consist of a tire with synthetic tension members bonded together in rubber. The flexible member shall be attached to flanges by means of clamping rings and cap screws, and the flanges shall be attached to the sub shaft by means of taperlock bushings which shall give the equivalent of a shrunk-on fit. There shall be no metal-to-metal contact between the driver and the driven unit.

B. Coupling sizes shall be as recommended by the manufacturer for the specific application, considering horsepower, speed of rotation, and type of service, and shall be installed as recommended by the manufacturer.

2.05 GUARDS

A. All exposed moving parts shall be provided with guards in accordance with the requirements of CAL/OSHA. Guards shall be fabricated of 14 gage steel, ½-13-15 expanded metal screen to provide visual inspection of moving parts without removal of the guard. Guards shall be galvanized after fabrication and shall be designed to be readily removable to facilitate maintenance of moving parts. Reinforced holes shall be provided.

2.06 NAMEPLATES

A. A nameplate shall be provided on all items of equipment and shall contain approved equipment name or abbreviation and equipment number. Equipment nameplates shall be engraved or stamped on stainless steel and fastened to the equipment in an accessible location with No. 4 or larger oval head stainless steel screws or drive pins. Nameplates for motor-driven equipment shall include capacity, head, horsepower, bearing data, model number and serial number of pump, blower, compressor and motor. The main sewage pump nameplates shall also include the impeller diameter.

2.07 TOOLS AND ACCESSORIES

A. The Contractor shall supply one (1) complete set of any special wrenches or other special tools necessary for the assembly, adjustment, and dismantling of the equipment. Special tools shall include any type of tool that has been specifically made for use on an item of equipment for assembly, disassembly, repair, and maintenance or is not available in current Snap-On Catalogue or Proto Professional Tools Full-Line Catalogue. When special tools are provided, they shall be marked or tagged, and a list of such tools shall be included with the maintenance and operation manuals describing he use of each marked tool. All wrenches and spanners shall be of best quality, hardened steel forgings with bright, finished heads and with work faces dressed to fit nuts. Each set of tools shall be neatly mounted in a toolbox of suitable design provided with a hinged cover.

PART 3 - EXECUTION

3.01 INSTALLATION

A. The Contractor shall cause each item of equipment provided as a part of the Contract Documents to be installed, aligned and tested by skilled workmen to the tolerances recommended by the equipment manufacturer. In addition, the equipment shall be installed, aligned and tested under the direction of installation engineers who have been factory trained by the equipment manufacturer. Upon completion of the Work and as a condition precedent to final acceptance, the Contractor shall furnish written certification from each equipment manufacturer that each item has been installed, aligned and tested correctly and that the installation meets all the manufacturer's requirements for efficient, trouble-free operation. This provision, however, shall not be construed as relieving the Contractor of his overall responsibility for the Work.

3.02 NOISE REQUIREMENTS

A. All equipment specified shall be tested for noise generation after installation. When tested, equipment shall include the complete driver and driven equipment. Three (3)

certified copies of the test shall be submitted to the Owner for approval prior to final acceptance.

3.03 SHOP INSPECTION AND SHOP TESTING

A. The Owner shall be granted reasonable access to the production and shop test areas of the equipment manufacturer's facility during manufacturing and testing.

B. The Contractor shall notify the Owner in writing, at least ten (10) working days prior to commencement of shop tests, of the time and place of all shop tests.

C. Inspection by the Owner will not relieve the Contractor of his responsibility for workmanship, materials and Conceptual Drawings and Specification requirements.

D. Manufacturer's standard test procedures shall be required and the manufacturer shall demonstrate that equipment meets all the requirements of these Conceptual Drawings and Specifications.

3.04 SHIPPING AND IDENTIFICATION

A. All shipments shall be "tagged" by the Contractor with "wired-on" metal or plastic tag clearly stenciled or lettered with paint or waterproof ink. The information on the tags and cartons shall include Contractor's order number, purchase order number, manufacturer's number, and equipment number. Any expense incurred by the Owner due to the Contractor's failure to do so will be backcharged or deducted from his Contract.

B. Each piece of equipment shall be provided with a substantial stainless steel nameplate, securely fastened in a conspicuous location and clearly inscribed with the manufacturer's name, year of manufacturer, serial number, principal rating data and equipment item number.

C. The equipment covered in these Specifications shall be fabricated in the minimum number of sub-assemblies necessary for transportation. Small components or assemblies shall be adequately boxed or crated to prevent damage during shipment.

D. Each assembly or package shall be identified with a durable shipping tag securely attached and plainly marked with the Contractor's order number, manufacturer's purchase order number and equipment number.

E. All openings shall be covered with plywood, plastic or wood plugs or shields to prevent debris from entering the assemblies. Each assembly or sub-assembly shall have lifting lugs to facilitate erection and subsequent removal when necessary.

3.05 OPERATION AND MAINTENANCE MANUALS

A. Operation and Maintenance manuals shall be furnished in accordance with Section 01730.

3.06 OPERATION AND MAINTENANCE INSTRUCTION

A. The Contractor shall provide instruction time in accordance with the detailed equipment specifications, after the equipment has been accepted by the Owner. The time shall be used to instruct the Owner's personnel in the proper operation and maintenance of the equipment. The manufacturer shall provide technical personnel familiar with the operation and maintenance of the equipment in making this presentation.

B. Training shall consist of on-site operation training, classroom training, operational, safety and emergency drills.

3.07 INSTALLATION OF EQUIPMENT

A. The Contractor's work procedure shall conform to the manufacturer's installation instructions unless expressly directed otherwise by the Owner.

B. Equipment shall be erected level and plumb on the existing foundations and supports at the locations and elevations shown on the Plans, unless otherwise directed, in writing, by the Owner and Resident Project Representative during installation. Any additional pads, plates and other appurtenances necessary for the installation shall be provided by the Contractor.

C. The equipment shall be brought to proper level with leveling nuts. After the machine has been leveled and aligned, the nuts on the anchor bolts shall be tightened to anchor the machine firmly into place against the leveling nuts.

D. The grout shall be installed in accordance with the manufacturer's instructions.

E. All equipment shall be installed in such a manner as to provide access for routine maintenance and lubrication as specified in Section 2.02 of this specification.

F. Equipment of a portable nature which requires no installation shall be delivered to a location designated by the Owner.

3.08 MECHANICAL START-UP

A. Once the equipment has been installed, complete with all auxiliary and support systems, and is ready for operation, the Contractor shall mechanically check out the equipment to verify that the equipment functions correctly under "non-process" conditions. The equipment shall be fine-tuned, adjusted, water tested, where applicable, and completely checked out before the equipment and support systems are considered ready for process start-up.

B. The Contractor will be responsible for coordinating this effort and providing all support services and facilities necessary for this work effort.

C. The equipment will not be considered ready for process start-up until the Owner is satisfied that the equipment has been satisfactorily checked out and successfully passed leakage and non-process test runs and appropriate training has been completed per the detailed equipment specifications.

3.09 FIELD SERVICE

It is understood that the Contractor and manufacturer share a joint responsibility in this Work. The Contractor shall provide the Manufacturer's qualified field representative and supporting personnel as required for the equipment furnished and installed under this Contract to perform the following:

A. Assistance during equipment installation shall be provided to align the equipment or check the alignment of pre-aligned equipment prior to making connections to or anchoring of the equipment.

B. Inspection during equipment installation work shall be provided to determine compliance with equipment erection methods and procedures recommended by the manufacturer.

C. Conduct the process start-up necessary to operate, adjust, calibrate and tune the equipment and systems into operating service in accordance with the design criteria described in each detailed equipment specification.

D. Conduct performance tests to demonstrate compliance with design criteria and performance guarantee set forth in the Specifications.

3.10 PROCESS START-UP

A. Once the equipment has been considered ready for process start-up and the support system can deliver the process material, the Contractor shall start up the equipment under process conditions and conduct performance tests to verify compliance with the Specifications. The Contractor shall give the Owner forty-eight (48) hours written notice of his intent to start up equipment under process conditions and conduct performance testing.

B. The Contractor shall provide the necessary supervision and technical personnel and services required to perform the work. The Owner shall coordinate this phase of the work with the Contractor and provide all necessary support services and facilities to assist the Contractor in performing the work.

C. The equipment shall be considered ready for a performance test only after the Contractor has demonstrated to the Owner that the equipment can operate continuously, without mechanical interruption under the process flow conditions for up to three (3) days, or such time as may be mutually agreeable to the Owner and Contractor.

D. After it has been determined that the equipment will operate satisfactorily under process conditions, the performance test shall be made by the Contractor to verify that the equipment can meet the requirements outlined in the Specifications. The performance test shall be based on maintaining the design requirements for a time period mutually agreeable to the Owner and the Contractor, or such period as is stipulated in the General Provisions.

3.11 OWNER FURNISHED EQUIPMENT

A. The Contractor shall notify the Owner when Owner furnished equipment is completely installed in accordance with the Owner furnished manufacturer's instruction and requirements of the Contract Documents and ready for operation testing. The Owner or Representative will schedule the manufacturer's representative to visit the site of the Work and inspect, check adjust if necessary and approve the equipment installation. If the manufacturer's representative cannot complete the testing and startup services due to the Contractor's negligence in installing the equipment, the Contractor shall be responsible for the costs of the service representatives' revisit to the site of the Work.

3.12 PERFORMANCE TESTS

A. Performance test procedures shall be prepared by the Contractor and approved (in writing) by the Owner a minimum of fourteen (14) days before performance tests are conducted.

B. Costs of all inspections, field service, mechanical start-up, run-in work, process start-up and performance tests shall be borne by the Contractor and shall be included in the total price bid for the Work.

C. The Contractor shall also agree to repay the Owner installation costs for any rejected equipment. The installation costs will be derived by the Owner based on actual costs charged for the installation of the equipment.

3.13 ACCEPTANCE OF EQUIPMENT BY THE OWNER

After all the conditions of the Performance Specifications have been satisfied, the Owner will designate in writing that the equipment is accepted, and at such time the Owner will be responsible for all further maintenance and operation of same. The warranty period for all equipment shall start on the date of final acceptance by the Owner.

END OF SECTION 01660

SECTION 01700 - PROJECT CLOSEOUT

PART 1 - GENERAL

1.01 FINAL CLEANUP

A. The Contractor shall promptly remove from the vicinity of the completed work, all rubbish, unused materials, concrete forms, construction equipment and temporary structures and facilities used during construction. Final acceptance of the Work by the Owner will be withheld until the Contractor has satisfactorily complied with the requirements for final cleanup of the site.

1.02 FINAL SUBMITTALS

A. The Contractor, prior to requesting final payment shall obtain and submit the following items to the Engineer for transmittal to the Owner:

1. Written guarantees, where required.

2. Operating manuals, technical manuals and instructions. The Contractor's attention is directed to the condition that one percent (1%) of the contract price will be deducted from any monies due the Contractor as progress payments if at the seventy-five percent (75%) construction completion point the approved technical manuals have not been submitted in accordance with Section 01300 - Contractor Submittals. The aforementioned amount will be retained by the Owner as the agreed estimated value of the approved technical manuals. Any such retention of money for failure to submit the approved technical manuals on or before the seventy-five percent (75%) construction completion point shall be in addition to the retention of any payments due to the Contractor as specified in Article 14 of the Standard General Conditions and the Agreement.

3. Manufacturers representatives' installation, testing and startup report.

4. Keying.

5. Maintenance stock items, spare parts and special tools.

6. Completion and Submittal of the As-Builts to the Resident Engineer.

7. Certificates of inspection and acceptance by local governing agencies having jurisdiction.

8. Releases from all parties who are entitled to claims against the subject project, property or improvement pursuant to the provisions of law.

9. Extension of Performance Bond in accordance with Article 5.01A of the Standard General Conditions, if applicable.

1.05 MAINTENANCE AND GUARANTEE

A. The Contractor shall provide a bond to comply with the guarantee requirements contained in Article 5.01A of the Standard General Conditions.

B. The Contractor shall make all repairs and replacements promptly upon receipt of written order from the Owner. If the Contractor fails to make such repairs or replacements promptly the Owner reserves the right to do the Work and the Contractor and his surety

shall be liable to the Owner for the cost thereof. Replacement of native material or aggregate fill, backfill or resurfacing where it has settled below the required finish elevations shall be considered as part of such required repair work.

END OF SECTION

SECTION 01722 – SURVEY AND CONSTRUCTION STAKING

PART 1 - GENERAL

The Contractor is responsible to engage a California-licensed Land Surveyor or Registered Civil Engineer authorized to practice land surveying to oversee the land survey work for this project.

1.01 DESCRIPTION

A. Permanent Survey Marker:

1. The Contractor shall be responsible for the preservation of survey monuments and benchmarks except as noted herein. At least ten (10) working days before the start of construction, the Contractor shall submit acceptable preconstruction survey tie notes to the Engineer's office. These tie notes shall be prepared by a California-licensed Land Surveyor or Registered Civil Engineer authorized to practice land surveying. These survey tie notes will be for all survey markers or benchmarks that may be lost or disturbed due to construction. Lost or disturbed monuments shall be replaced at the Contractor's expense by a California Licensed Land Surveyor or Registered Civil Engineer authorized to practice land surveying. Post-construction survey monument ties acceptable to the Engineer shall be submitted to the Engineer's office before the completion of the Work (see "Monuments", Section 8771, Land Surveyors Act, Division 3, Chapter 15 of the Business and Professions Code). The California Licensed Land Surveyor will re-establish the monuments and benchmarks where survey services are provided by the California Licensed Land Surveyor, providing the Contractor protects the preconstruction reference points. In this case, where the monuments are to be removed or damaged by the Contractor, the Contractor shall notify the Engineer in writing ten (10) calendar days before starting the Work.

B. Lot Stakes:

1. The Contractor shall preserve property line and corner survey markers, except where their destruction is unavoidable. The lot stakes shall be replaced per Item A.1 above. Markers that otherwise are lost or disturbed by its operations shall be replaced at the Contractor's expense by the Land Surveyor/Engineer contracted by the Contractor.

C. Survey Services:

1. The California Licensed Land Surveyor or Registered Civil Engineer authorized to practice land surveying contracted by the Contractor will perform and be responsible for the survey work at the Site unless otherwise noted on the Plans or Specifications. The Contractor shall preserve construction survey stakes and marks for the duration of their usefulness. If any construction survey stakes are lost or disturbed and need to be replaced, such replacement shall be accomplished by the Engineer at the expense of the Contractor.

2. The California Licensed Land Surveyor or Registered Civil Engineer authorized to practice land surveying contracted by the Contractor shall establish horizontal and vertical control points for construction. The Contractor shall notify the Engineer in writing at least five (5) full working days before survey services are required in connection with the laying out of any portion of the work. The Contractor shall dig all holes necessary for line and grade stakes when requested by the Engineer.

3. The Contractor shall be responsible for their own layout based on the Land Surveyor/Engineer's survey stakes and cut sheets. The Contractor shall allow sufficient time for checking and issuance of cut sheets by the Engineer.

4. Unless otherwise specified, stakes will be set and stationed by the Land Surveyor/Engineer for curbs, ribbon gutters, headers, sewer pipelines, water pipelines, storm drains, structures, and rough grade. A corresponding cut or fill to finished grade (or flowline) will be indicated on the cut sheet.

D. Line and Grade:

1. The California Licensed Land Surveyor or Registered Civil Engineer authorized to practice land surveying contracted by the Contractor shall set alignment and grade stakes only for all on-site pipelines that are three-inches (3") in diameter or larger. The Contractor shall furnish all other lines and grades required for proper execution of the work.

2. After exterior walls have been located for the building, the Contractor shall be responsible for the location of all interior construction including interior piping within the building.

3. All work shall conform to the lines, elevations, and grades illustrated on the Plans.

4. Three consecutive points set on the same slope shall be used together so that any variation from a straight grade can be detected. Any such variation shall be reported to the Engineer in writing. In the absence of such written notification, the Contractor shall be responsible for any error in the grade of the finished work.

5. Grades for underground pipelines will be established by the offset hubs at the surface of the ground. The Contractor shall be responsible for transferring the grades to the bottom of the trench and pipeline.

E. Benchmarks:

1. The Contractor shall use the benchmarks illustrated on the Plans to conduct grading work at the project site. The Contractor shall be allowed to establish temporary benchmarks; however, the Contractor shall establish the temporary benchmarks from the benchmarks illustrated on the Plans. The Contractor shall provide the Engineer with fully prepared Level Notes substantiating the correct elevation of the temporary benchmark.

F. The Contractor shall provide grade checkers to verify subbase, subgrade and final grade elevations prior to those grades being checked, verified and approved by the Engineer. The Contractor shall provide grade checkers to place bluetop staking in parking lots, basins, roadways, concrete surfaces or other specified locations as required by Drawings. Bluetop stakes are stakes set to grade. The Engineer will verify the grading work after the bluetop stakes have been placed by the grade checkers. The Contractor shall review Section 02200 - Earthwork; Section 02221 - Trenching, Backfilling and Compacting and Section 02510 - Asphalt Concrete and Paving, required for any required bluetop staking for this project.

G. The California Licensed Land Surveyor or Registered Civil Engineer authorized to practice land surveying contracted by the Contractor shall provide two (2) sets of cut sheets to the Contractor within 24 hours after completing a staking activity.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 02200 – Earthwork

B. Section 02221 – Trenching, Backfilling and Compacting

C. Section 02510 – Asphalt Concrete and Paving

PART 2 - EXECUTION

2.01 SURVEY REQUIREMENTS

2.01.1. Lath and hubs shall be placed along the limits of construction on 50 foot on center and at corners at the commencement of construction.

2.01.2. Establish demolition lines with a painted line along the existing native earth and paved areas.

2.01.3. Place offset hubs 25 feet on center and at angle points along the installation of sanitary sewer and water pipelines. Cut and fill vertical distances from the hubs to the bottom of the pipe trench grades will be established.

2.01.4. Place offset hubs along the perimeter of the structures and equipment, at intervals determined by the Contractor, to properly establish the corners of flatwork including sidewalk, site furnishing slabs, pads, etc., end of curve radius's, beginning of curve radius's, ¼ and ½ delta angle points at curb radius's and flatwork ending points, angle points and grade breaks of structures/sidewalk/slabs/pads/gutter, at an offset distance established by the Contractor for the rough grading/final grading work required to establish subgrade/subbase grade for the concrete infrastructure. Cut and fill vertical distances from the hubs to the flowline grades and subbase grades will be established.

END OF SECTION 01722

SECTION 01730 - OPERATION AND MAINTENANCE MANUALS

PART 1 - GENERAL

1.01 DESCRIPTION

The Contractor shall furnish to the Owner's representative six (6) identical sets of operation, maintenance, and technical manuals. The Contractor shall include in the manuals for each item of mechanical, electrical and instrumentation equipment the following:

1. Complete operating instructions, including recommended troubleshooting and start-up procedures; tabulation of proper settings for all pressure relief valves, pressure switches and other related equipment protection devices; detailed test procedures to determine performance efficiency of equipment; list of all electrical relay settings including alarm and contact settings.

2. Preventive maintenance procedures and schedules, including required lubricants, filters, adjustments, and special tools.

3. Parts lists, by generic title and identification number, complete with exploded views of each assembly. Spare parts information shall be included for each mechanical, electrical and instrumentation equipment. The spare parts list shall include the current list price of each spare part. The spare parts list shall be limited to those spare parts which each manufacturer recommends be maintained by the Owner in inventory at the plant site. Each manufacturer or supplier shall indicate the name, address, and telephone number of its nearest outlet for spare parts to facilitate the Owner in ordering.

4. Disassembly and reassembly instructions, including required special tools.

5. Record drawings including diagrams and schematics as required under the electrical and instrumentation portions of these specifications.

1.02 OPERATIONS AND MAINTENANCE MANUALS

A. General:

1. The "Operating and Maintenance Manual" is a bound compilation of drawings and data required for each project. These manuals, complete with drawings and data, shall be furnished to the Owner.

2. The Contractor has overall responsibility to obtain the necessary data from and compile the data as set forth in this specification, including items or equipment purchased by the Owner and delivered to the Contractor for installation.

3. The number of binders (or "volumes") required for each individual project will depend on the amount of information to be catalogued.

4. All information included shall be legible and sufficiently marked to indicate the exact size, model, type, etc., of equipment furnished and installed.

B. Purpose: The Operating and Maintenance Manual is prepared to provide a ready reference to all important mechanical, electrical, and instrumental equipment components installed at the project. It is also to provide the necessary operating and maintenance data for use by service personnel. It is also to provide information required for checking equipment performance or for planning of plant expansion or redesign.

C. Quantity and Preparation (Submit through Owner's representative):

1. Operation and Maintenance Manuals shall be prepared for the project.

A. Three (3) sets to the Owner's representative.

B. Three (3) sets to Owner.

2. The quantities of drawings, manufacturer's literature, or other data required for these manuals are in addition to those otherwise required for normal distribution for approval during the construction period.

PART 2 - MATERIALS AND METHODS

2.01 PAGE SIZE

A. All pages shall be standard 8-½ x 11 inches size or approximate multiples (preferably 11 x 17 inches) folded to 8-½ x 11-inch manila pockets, which shall have standard three-ring side punching for insertion in the binders. The equipment name, drawing description and number shall be written on the face of each manila pocket.

2.02 DRAWINGS

A. All drawings larger than 8-½ x 11" shall be folded and inserted in individual 8-½" x 11" manila pockets, which shall have standard three-ring side punching for insertion in the binders. The equipment name, drawing description and number shall be written on the face of each manila pocket.

2.03 BINDERS

A. Binders shall be Buckram binders with block lettering for sheet size 8-½ x 11 inches with 2" to 3-½" expandable metal capacity as required for the project. The number of binders, however, shall be based on not filling them beyond 4".

B. The following information shall appear on the front cover and backbone:

1. "Operation and Maintenance Manual"

2. Project Name (Holtville Water System Improvement Project) and volume number if more than one volume

3. Owner's name

4. Owner's representative's name

5. General Contractor's name (need not be printed on the backbone)

2.04 CONTENTS AND INDEXING

A. Manuals shall contain descriptions of the plant systems in sufficient detail to adequately indicate the type of systems installed and the basic details of their operation.

B. All purchased equipment data shall be used to designate the sections. Within each section additional indexing of component parts may be required.

C. Operation and Maintenance Manuals shall contain to the fullest extent all possible information pertinent to the equipment. The arrangement and type of information to be filed shall be as follows:

1. Copy of purchase order change (if any).

2. Outline drawings, special construction details, "as built" electrical wiring and control diagrams for all major and supplementary systems.

3. Manufacturer's test or calculated performance data and certified test curves.

4. Installation, operating and maintenance instructions, including a complete parts list and sectional drawing with parts identification numbers. Mark with model, size and plan number.

5. Manufacturer's brochure marked to indicate exact equipment purchased. Brochures on component parts supplied by a manufacturer with his equipment, but not manufactured directly by him, shall also be included.

6. The serial numbers of each item of equipment installed are to be listed with the model numbers and plan symbols.

7. Written warranties.

8. Include a Table of Contents. The contents shall be divided with tabbed index dividers into the following suggested parts:

   Part I Treatment Plant and System Descriptions

   Part II Purchased Equipment Data

   Part III Test Reports and Valve Charts

   Part IV Start-Up and Operation

   Part V Preventative Maintenance Recommendations

9. A copy of the approved submittals for each piece of equipment.

10. A copy of all testing, adjusting and balancing reports.

11. Wiring diagrams marked with model and size and plan symbol.

12. Operating and Maintenance Manuals data for Part I shall be obtained directly from the mechanical and electrical consultants. (All consultant preparation cost.)

13. The index shall contain the name and address of the manufacturer and, if different, where replacement and repair parts may be obtained.

2.05 EQUIPMENT SUMMARY DATA FORMS INFORMATION SHEET

Equipment Summary Data Forms are intended to provide the Maintenance Department with sufficient information to catalogue newly purchased equipment items installed at the project site. This information is used for inventory purposes as well as for equipment performance tracking purposes. Each item of equipment installed at the facility must be documented on Equipment

Summary Data Form. Examples of the form are herein. Additional requirements regarding submittal format, quantities, etc, are found elsewhere in this Specification.

1. Equipment item (included industry-accepted nomenclature).
2. Manufacturer address, phone/fax numbers
3. Supplier address (if different than above), phone/fax numbers
4. Equipment serial and model numbers
5. Size
6. Capacity
7. Rated output
8. Drive motor data (as appropriate).

In addition, information specific to the item described shall be provided as indicated on the following form.

EQUIPMENT SUMMARY
DATA FORM

EQUIPMENT ITEM: _____

EQUIPMENT COST: _____

EQUIPMENT SUPPLIER: _____

COMPONENT INFORMATION: **NAMEPLATE DATE:** **MANUFACTURER:**	
EQUIPMENT MODEL NO.:	**EQUIPMENT SERIAL NO.:**
EQUIPMENT MODEL DESIGNAITON:	**TYPE:**
SIZE:	**RATED OUTPUT:**
CAPACITY:	**SERVICE:**
COMPONENT INFORMATION: DRIVE MOTOR DATA **MANUFACTURER:**	
SERIAL NO.:	**HORSEPOWER:**
MODEL:	**FRAME:**
TYPE:	**VOLTAGE:**
ENCLOSURE:	**AMPERAGE:**

PHASE: **HERTZ:**	**SERVICE FACTOR:**
LUBRICATION REQUIREMENTS: MOTOR	
COMMENTS:	

2.06 INFORMATION SHEET FOR EQUIPMENT MAINTENANCE SUMMARY FORMS

Equipment Maintenance Summary forms are intended to provide the Maintenance Division with information sufficient to properly diagnose (troubleshoot, repair, check-out, and return an item of equipment to service. Standard information contained in each Form shall be as follows:

In addition, Maintenance information required to troubleshoot, repair, and return electrical/electronic equipment to service (including set point, derivatives, etc.) shall be included as required. The Maintenance Summary Form attached in intended to serve as a (minimum) guide to the information required per item of equipment. Additional requirements regarding submittal format, quantities, etc. are found elsewhere in this Specification.

1. Equipment item (include industry-accepted nomenclature)

2. Manufacturer address, phone/fax numbers

3. Equipment serial number(s)

4. Weight of individual components (over 100 pounds)

5. Nameplate date (including voltage, horsepower, lubrication requirements, speed, etc.)

6. Manufacturer's local representative address, phone/fax numbers

7. Maintenance operation(s) required. Listing shall include (1) Maintenance Operation to be performed. (2) Frequency of said Maintenance Operation based on actual service conditions of installed equipment (i.e., type of duty, environmental factors). Reference shall be made to the appropriate section of the manufacturer's technical literature.

8. Lubricant list. List shall include a primary and two secondary manufacturer-approved lubricants.

9. Spare parts required for a minimum of one (1) year of equipment operation based on anticipated actual service conditions. Also the name, address, and phone number of the recommended source of spare parts shall be included if different than manufacturer's representative.

TYPICAL MAINTENANCE SUMMARY FORM

NOTE: SUPPLEMENTARY INFORMATION SHALL BE INCLUDED AS APPROPIATE

1. EQUIPMENT ITEM: _____

2. MANUFACTURER: _____
   ADDRESS: _____
   TELEPHONE NO.: _____ FAX NO.: _____

3. EQUIPMENT SERIAL/IDENTIFICATION NUMBERS: _____

4. WEIGHT OF INDIVIDUAL COMPONENTS (OVER 100 POUNDS): _____

5. NAMEPLATE DATA: _____

6. MANUFACTURER'S LOCAL REPRESENTATIVE: _____
   ADDRESS: _____
   TELEPHONE NO.: _____
   FAX NO.: _____

7. MAINTENANCE OPERATION(S) REQUIRED: (attach separate sheet if required).

OPERATION	FREQUENCY	COMMENTS

8. LUBRICANT LIST. Provide Reference symbol used in items recommended.

SHELL	STANDARD OIL	GULF	ARCO	EQUAL

9. RECOMMENDED SPARE PARTS LISTS FOR MINIMUM OF ONE (1) YEAR UNINTERRUPTED SERVICE. (Attach separate sheet if required).

ITEM	PART NO.	QUANTITY REQUIRED (per unit)	UNIT COST	COMMENTS

END OF SECTION 01730

SECTION 01783 – AS-BUILT DRAWINGS

PART 1 - GENERAL

1.01 DESCRIPTION

A. As-Builts are full size drawings (Plans) and Record Project Manual which are marked up during construction to delineate the actual in-place constructed conditions. As-Builts shall be provided by the Contractor for this Project. Requirements for As-Builts, as specified elsewhere, shall supplement the requirements specified herein.

B. As-Builts shall include all changes in the Plans including those issued as Change Orders, Plan Clarifications, Addenda, Notice to Bidders, responses to Request for Information, Project Site Memos, and any additional details needed for the construction of the Project but not shown on the Plans. Any substructures encountered while excavating that are left in place shall be located by survey, to the satisfaction of the Engineer, shown, and identified on the As-Builts. All substructures including, but not limited to, concrete structures, electrical conduit and duct banks, drains and sanitary sewer pipelines, process piping, water lines, etc, whose installed location differs from that shown on the original Plans shall be precisely located by survey to the satisfaction of the Engineer and recorded on the As-Builts before backfilling.

C. As-Builts shall be marked with red ink or chemical fluid on one (1) set of full-size prints to produce a record of the complete installation. Any additional drawings that may be required to indicate record conditions shall be prepared on 24" x 36" paper. All additions to the plans shall employ and use drafting standards which are consistent with the drafting standards used in the Contract.

D. The As-Builts, including those of all Subcontractors, shall be kept by the Contractor in the Contractor's Project Site Office, shall be updated during construction, and shall be available for the Engineer's inspection and copying at all times. The Engineer will review the As-Builts prior to submittal of all Monthly Payment Requests. If, in the opinion of the Engineer, the As-Builts are not current, approval of the Monthly Payment may be withheld until the drawings are made current.

E. Where the Plans are diagrammatic or lacking precise details, the Contractor shall produce dimensioned full-size sheets as the As-Builts. For installations outside of the structures, the locations shall be given by coordinates and elevations. Where substructures are encased in concrete, the outside dimensions of the encasement shall also be given.

F. In the case of those Drawings which depict the detail requirements for equipment to be assembled and wired in the factory, the As-Builts shall be updated by indicating those portions which are superseded by final Shop Drawings and by including appropriate reference information describing the Shop Drawings by manufacturer, drawing and revision numbers.

G. At the Completion of the Work and after Final Inspection, the Contractor shall copy As-Built data, using red ink, onto a new set of Plans provided by the Owner. The Contractor shall certify to the completeness and accuracy of the "as installed" information indicated on the new set of Plans with its signature. The Contractor shall then deliver as a submittal to the Engineer, for review and approval, both the field developed As-Built Plans and the final signed As-Built Plans as a condition precedent to the Owner's release of any retained funds.

END OF SECTION

SECTION 02050 - DEMOLITION AND SALVAGE

PART 1 - GENERAL

1.01 DESCRIPTION

A. The Contractor shall provide demolition and removal of existing structural materials, vegetation, exterior fencing, utility facilities, miscellaneous equipment, and facilities within the property boundary of project site in accordance with the requirements of the Contract Documents and as illustrated on the Improvement Plans.

Bidders shall examine the project site thoroughly during the bidding phase to verify the existing facilities to be demolished. Bidders shall immediately notify the Owner if there are any discrepancies between the site conditions and the demolition items to be removed and disposed of by the Contractor, as illustrated on the Improvement Plans. All remaining demolition items not struck through with a line on the Improvement Plans shall be completed by the Contractor.

The demolition operations of the existing structures include a complete demolition of the supporting foundation such as concrete footings, columns and beams, etc. on which the existing structures are mounted on.

B. The Contractor shall repair or replace, without cost to the Owner and to the satisfaction of the Engineer, existing facilities disturbed or damaged during demolition and removal operations.

C. Immediately upon removal of demolition items, the Contractor shall legally dispose of demolished items not to be salvaged. Demolished items not to be salvaged shall be removed from the Site within two (2) calendar days of the commencement of demolition activities. ***Unless noted in the Plans, the Owner reserves the right to salvage any of the existing material or equipment. The Contractor, upon being notified by the Engineer, shall salvage and relocate to an Owner-designated, on-site storage area any materials or equipment the Owner desires to keep. The cost of the removal and relocation of the items shall be included in the contract price.*** No demolished items shall be sold while on the Owner's property.

END OF SECTION

SECTION 02140 - DEWATERING

PART 1 - GENERAL

1.01 DESCRIPTION

A. Design, furnish, install, maintain, operate and remove complete temporary dewatering system(s) as required to lower and control water levels and hydrostatic pressures during construction and dispose of pumped water.

B. Obtain necessary permits from governing agencies for the discharge or disposal of the dewatering water.

1. Prior to construction, the Contractor shall obtain a permit from the Regional Water Quality Control Board for dewatering activities. The permit may be conditioned to protect the water quality in the project vicinity. These conditions may include treatment, discharge sampling, monitoring and reporting.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 01330 – Submittals / Shop Drawings

B. Section 01520 – Temporary Facilities

C. Section 02150 – Sheeting, Shoring, and Bracing

D. Section 02221 – Trenching, Backfilling, and Compacting

1.03 SITE CONDITIONS

Ground water levels are expected to be within ten (10) feet of the existing surface grade.

The Contraction shall engage the services for a Geotechnical firm to provide the level of the ground water at or near the pump lift station. The Geotechnical firm shall perform any additional testing necessary to evaluate engineering properties for the design of a dewatering system, if applicable.

1.04 DEFINITIONS

Dewatering includes lowering the water table and intercepting seepage which would otherwise emerge from the faces or bottom of the excavation.

1.05 QUALITY ASSURANCE

Before dewatering is commenced, the Contractor shall obtain the acceptance of the Engineer for the method, installation and details of the dewatering system that is proposed to be used. To that end, the Contractor shall submit to the Engineer plans setting forth the details of the proposed dewatering systems. The dewatering system plans shall be in sufficient detail to indicate sizes of pumps, piping, appurtenances, the ultimate disposal point for water and to permit the Engineer to judge the overall completeness and effectiveness of the proposed system.

The control of groundwater shall be such that softening of the bottom of excavations, or formation of “quick” conditions or “boils”, do not occur. Dewatering systems shall be designed and operated so as to prevent removal of the natural soils.

The Contractor shall select the particular method of dewatering to be employed.

1.06 DEWATERING SUBMITTALS

A. At least thirty (30) days prior to installation of the dewatering system, submit six (6) copies of working informational and scheduling drawings and the following design data:

1. The proposed type of dewatering system, including relief of hydrostatic head and maintenance of the excavations in a dewatered and in a hydrostatically relieved condition.

2. Arrangement, location and depths of the components of the system.

3. A complete description of equipment to be used with installation, operation, and maintenance procedures.

4. Standby equipment and emergency power supply.

5. Location and size of sumps and discharge lines, including their relation to water disposal sites.

6. Types and sizes of filters.

7. Location, types and depths of wells and/or well points and observation wells.

8. Proposed locations of observation wells.

9. Design calculations demonstrating adequacy of the selected system and equipment.

10. Coordination with earth support system design and excavation operations.

B. Review of dewatering and recharge system by the Engineer shall not relieve the Contractor from the responsibility for the adequacy of these systems to achieve the specified results.

PART 2 - PRODUCTS

2.01 GENERAL

The Contractor shall furnish, install, operate and maintain all machinery, appliances, and equipment to maintain all excavations free from water during construction, and shall dewater and dispose of the water so as not to cause injury to public or private property, or to cause a nuisance or menace to the public.

The dewatering system shall be installed and operated so that the groundwater level outside the excavation is not reduced to the extent which would cause damage or endanger adjacent structures.

The static water level shall be drawn down a minimum of three feet (3') below the bottom of the excavation in order to maintain the undisturbed state of the foundation soils and to facilitate the placement of fill or backfill compacted to the required density.

2.02 SUMP PUMPING

Sumps shall be no deeper than four feet (4') and shall be at the low point of excavation. Excavation shall be graded to drain to the sumps.

2.03 WELL POINTS

The annular space between the pipe and the borehole of the well point shall be sealed near the top of the well point to prevent vacuum leaks. Installation shall be carried out in such a way so as not to excessively disturb in situ material.

2.04 DEEP WELLS

Deep wells shall be cased with PVC, steel, or other suitable casing material. The casing shall have a perforated section at the water producing zone. The annular zone between the casing and the borehole may be gravel packed. Installation shall be carried out by any acceptable method.

2.05 VERTICAL SAND DRAINS

Vertical sand drains shall be installed with minimum disturbance to in situ material.

PART 3 - EXECUTION

3.01 GENERAL

One hundred percent (100%) standby pumping capacity shall be available on site at all times and shall be connected to the dewatering system piping to permit immediate use. In addition, standby ancillary equipment and appliances for all ordinary emergencies, and competent workmen for operation and maintenance of all dewatering equipment shall be on site at all times. Standby equipment shall include emergency power generation and automatic switchover to the emergency generator when normal power fails.

Dewatering systems shall not be shut down between shifts, on holidays, on weekends, or during work stoppages.

The Contractor shall control surface water to prevent entry into excavations.

At each excavation, a minimum of four (4) temporary observation wells (piezometers) shall be provided to continuously monitor the groundwater level.

3.02 DRAINAGE OF EXCAVATED AREAS

A. Collect surface water and seepage which may enter the excavation and divert the water into a sump so that it can be drained or pumped.

B. Install settling basins or other approved apparatus as required to reduce the amount of fine particles which may be carried by water diverted into the discharge line.

C. Backfill sumps and settling basins when no longer required with granular material, concrete or other material as approved by the Engineer.

3.03 DISPOSAL

A. Dispose of all water in accordance with applicable provisions of all Federal, State, and local regulatory boards having jurisdiction over water discharges. Water containing soil, silt or chemical contaminants shall not be discharged into natural watercourses, municipal drains or sewers.

B. The Contractor shall obtain the necessary discharge permits from the Regional Water Quality Control Board for proposed ground water dewatering discharges.

C. The Contractor shall submit to the Engineer copies of all permits obtained for the discharge or disposal of dewatering water. Copies of the permits shall be maintained on the Site at all times.

D. The Contractor shall be familiar with and shall conform to the requirements of the General Waste Discharge Requirements as they relate to the quantity, quality, testing, reporting, and all other aspects of construction dewatering discharges. The Contractor shall perform all construction dewatering disposal in accordance with the provisions of the General Waste Discharge Requirements.

END OF SECTION 02140

SECTION 02150 - SHEETING, SHORING AND BRACING

PART 1 - GENERAL

1.01 DESCRIPTION

This section provides requirements for sheeting, shoring, bracing, wales, posts, piling, anchorages and fastenings or other excavation supports, both temporary or permanent, for accomplishment and protection of Work.

1.02 QUALITY ASSURANCE

A. Design Requirements:

In accordance with Section 6500 and Section 6705 of the Labor Code, the Contractor is required to obtain a permit, for the excavation of trench which is five feet (5') or more in depth and into which a person is required to descend, from the Division of Industrial Safety.

The Contractor shall furnish all labor, equipment and materials required to design, construct and remove all sheeting, shoring and bracing or other equivalent method of support for the walls of open excavations required for the construction of this project.

Excavation of any trench, pad area, foundation area, or structure five feet (5') or more in depth shall not commence until the Contractor has received approval from the Engineer of the Contractor's detailed plan for worker protection from the hazards of trench or soil wall collapse/failure.

Such plan shall be submitted at leave five (5) days before the Contractor intends to begin excavation and shall show the details of the design of shoring, bracing, sloping or other provisions to be made for worker protection during such excavation. No such plan shall allow the use of shoring, sloping or a protective system less effective than that required by the Construction Safety Orders of the Division of Industrial Safety. The plan shall be prepared and signed by an engineer who is registered as a Civil or Structural Engineer in the State of California.

Prior to the beginning of excavations requiring shoring, the Contractor shall designate in writing to the Engineer, the person responsible to supervise the project safety measures and the person responsible to supervise the installation and removal of sheeting, shoring and bracing.

In addition to shoring the excavations in accordance with minimum requirements of the Industrial Safety Orders, it shall be the Contractor's responsibility to provide any and all additional shoring required to support the sides of the excavation against the effects of loads which may exceed those derived by using the criteria set forth in the Industrial Safety Orders. The Contractor shall be solely responsible for any damages which may result from his failure to provide adequate shoring to support the excavation under any or all of the conditions of grading which may exist, or which may arise during the construction of the project.

B. Material Standards:

Furnish lumber for shores, wales, and sheeting of grading required by the American Lumber Standards for the particular application.

1.03 SUBMITTALS

Contractor shall submit complete calculations of the sheeting system including sizing of sheeting wales, rakers, anchor system, struts, earth anchors, anchor piles, tie rods or any other components pertinent to the design prior to the start of any Work involving sheeting and bracing. All designs submitted shall be stamped and signed by an Engineer with a Civil or Structural designation with an active registration in the State of California.

1.04 JOB CONDITIONS

Buried debris may be found at some locations. Federal and local agency requirements for safety of job personnel and public will apply to work under the Section.

1.05 ALTERNATIVES

The use of application of alternative methods and materials, and the employment of proprietary systems under lease or franchise in lieu of that specified herein, may be allowed. Demonstration of suitability and compliance with these Specifications will be required. The application of alternative methods will be approved by the Engineer.

1.06 RELATED WORK SPECIFIED ELSEWHERE

A. Section 03300 – Cast-In-Place Concrete

PART 2 - PRODUCTS

2.01 MATERIALS

A. Lumber:

1. Temporary Shores, Wales and Sheeting: Furnish structural grade planks, beams and posts as defined and specified for stress-grade lumber in the American Lumber Standards. Lumber may be rough, untreated, in random lengths, and shall be of standard dimensions.

2. Permanent Sheeting: When permanent sheeting is called for on the Drawings, provide and install planks, beams, posts and timers of unseasoned, rough, new southern yellow pine or Douglas Fir meeting the requirements of ASTM Standard D25, Class “C”. In lieu of the above, lumber dressed to standard dimensions, dried and treated in accordance with Standard T-3 of the American Wood Preservers’ Association may be utilized.

B. Fastenings:

Provide fastenings for permanent sheeting as recommended in the National Design Specification for stress-grade lumber and its fastening.

PART 3 - EXECUTION

3.01 INSTALLATION

Install sheeting and bracing for trench and structure excavation progressively as the removal of excavated material requires. Butt planks to exclude groundwater and fines, preventing the erosion of voids outside sheeting. In soft, wet ground drive sheeting to a lower level as excavation

progresses to that sheeting is embedded in undisturbed earth. Bracing sheet piling may be permitted to penetrate the structural concrete only as directed by the Owner. Refer to Section 03300 – Cast-in-Place Concrete. Install wales and struts at close intervals so as to prevent displacement of the surrounding earth and to maintain safe conditions in the Work area. Any damage proven to result from improper installations shall be the responsibility of the Contractor. Temporary sheeting for trench and structure excavation may be removed and reused. Withdraw individual planks alternately as the backfill is raised, maintaining sufficient sheeting and bracing to protect the Work and workmen. Remove bracing completely. Where unstable conditions occur in the underlying strata from any cause, and withdrawal of sheeting will endanger the Work, a portion of the sheeting, including bracing, may be left in place with the approval of the Owner. Remove all wood within a zone extending four feet (4') below finished grade. Leaving such material in place shall not be cause for an increase in the contract price. The use of horizontal strutting below the barrel of a pipe or the use of a pipe as support will not be permitted. Sheet piling and timers in trench excavations shall be withdrawn in a manner so as to prevent subsequent settlement of the pipe or additional backfill loadings which might overload the pipe. Trench sheeting below the top of the pipe shall be left in place.

END OF SECTION 02150

SECTION 02200 - EARTHWORK

PART 1 - GENERAL

1.01 DESCRIPTION

A. The Work of this Section includes all earthwork required for construction of the Work. Earthwork shall include, but not be limited to the loosening, removing, loading, transporting, depositing and compacting in its final location of all materials wet and dry, as required for the purposes of completing the work specified in the Contract Documents which shall include, but not be limited to: the sawcutting and removal of A.C. pavement, P.C.C. concrete and underlying material to a subbase design grade indicated on the Plans, the installation of subbase material to a subbase grade beneath A.C. pavement and concrete infrastructure, the excavation of pipeline trenches, the installation of backfill material within pipeline trenches, excavations for above-grade and below-grade structures, backfill requirements for material to be placed beneath above-grade and below-grade structures, backfill requirements for the areas surrounding above-grade and below-grade structures, backfilling of manholes and catch basins, construction of earth embankments, backfilling of depressed areas, abandoned ponds or depressed areas resultant from demolition, the disposal of excess excavated materials, barrow of materials to make up deficiencies for fills; and all other incidental earthwork, all in accordance with the requirements of the Contract Documents.

Principal work items included in this Section are:

1. Site preparation, clearing, and grubbing.
2. Preparation of fill areas.
3. Excavation and controlled fill construction.
4. Structural excavation and backfills.
5. Disposal of surplus and/or unsuitable materials.
6. Dust control and drainage control.
7. Grading
8. Clean-up.

1.02 REFERENCE STANDARDS

ASTM C 131	Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM D 75	Practice for Sampling Aggregates
ASTM D 422	Method for Particle-Size Analysis of Soils
ASTM D 698	Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures, Using 5.5-lb (2.49-kg) Rammer and 12-in (304.8-mm) Drop

ASTM D 1556	Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D 1557	Test Method for Moisture-Density Relations of Soils Using Remmer and Drop
ASTM D 1682	Test Method for Breaking Load and Elongation of Textile Fabrics
ASTM D 2419	Test Method for Sand Equivalent Values of Soil and Fine Aggregate
ASTM D 2487	Classification of Soils for Engineering Purposes
ASTM D 2922	Test Method for Density of Soil in Places by Nuclear Methods (Shallow Depth)
ASTM D 3017	Test Method for Water Content of Soil and Rock in Place by Nuclear Methods
ASTM D 3776	Test Method for Mass Per Unit Area (Weight) of Woven Fabric
ASTM D 4253	Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Plate
ASTM D 4254	Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density
ASTM D 4751	Test Method for Determining the Apparent Opening Size of a Geotextile
CAL-OSHA	Title 8 General Industry Safety Orders

1.03 RELATED WORK SPECIFIED ELSEWHERE

A. Section 02150 - Sheeting, Shoring, and Bracing

B. Section 02221 - Trenching, Backfilling, and Compacting

C. Section 02640 - PVC Pipe

D. Section 02726 - Manhole and Precast Vault Construction

1.04 DEFINITIONS

A. Site: The property is owned by the City of Calipatria. The site includes Hernandez Park and Road Right of Ways.

B. Controlled Fill: Compacted suitable fill material in all areas of the site requiring filling to grade as shown on the Plans.

C. Structural Fill: Compacted suitable fill material which will support a structure or some part of a structure. This includes support material for P.C.C. structures and pads.

D. Structural Backfill: Compacted suitable material placed between the wall of a structure and construction excavation slope up to finished grade.

E. Suitable Material: As specified herein shall be any material imported or excavated from the cut areas that is, in the opinion of the Engineer, suitable for use in constructing fills.

F. Waste Excavation: Also Surplus Material. Material from project excavations which is not suitable for use in backfill or compacted fills or is in excess of that required to be used for backfill or to construct fills.

G. Pipe Zone Backfill: Material suitable for placement below or surrounding the pipe to a given vertical distance above the pipe as required by the pipe section.

H. Pipe Trench Backfill: Material suitable for placement from the pipe zone to finish grade or to pavement subbase material.

1.05 SITE INVESTIGATION

A. Soil Investigation Report: A Geotechnical Report has been prepared for this project and is included in the Special Conditions Section of the Specifications.

B. Contractor's Responsibility: The Contractor shall carefully examine the site and make all inspections necessary in order to determine the full extent of the work required to make the completed Work conform to the Plans and Specifications. The Contractor shall satisfy himself/herself as to the nature and location of the Work, conditions, the conditions of the existing ground surface, and the character of equipment and facilities needed prior to and during prosecution of the Work. The Contractor shall satisfy himself/herself as to the character, quality, and quantity of surface and subsurface materials or obstacles to be encountered. The Contractor shall review water table conditions. Any inaccuracies or discrepancies between the actual field conditions and the Plans, or between the Plans and Specifications must be brought to the Engineer's attention in order to clarify the exact nature of the Work to be performed.

C. Existing Elevations: All existing elevations illustrated on the Plans are approximate. The Contractor shall recognize and acknowledge the condition that the bid lump sum price shall include all earthwork activities irrespective of the possible localized difference in contour elevations and actual ground; and that there will be no additional compensation from the Owner for earthwork changes, engineering, or field staking in this regard.

1.06 SAFETY

The Contractor shall familiarize himself/herself with, and shall at all times conform to, the regulations of the "OSHA General Industry Occupational Safety and Health Standards", and "OSHA Safety and Health Regulations for Construction Safety Orders" and "Trench Construction Safety Orders" of the State of California, Department of Industrial Relations, Division of Occupational Health and Safety. A copy of these documents shall be kept on the job site.

1.07 ENVIRONMENTAL SAFEGUARDS AND REGULATIONS

The Contractor shall comply with regulations in force at all times to prevent pollution of air and water.

1.08 GEOTECHNICAL TESTING

The Contractor is responsible to engage a qualified Geotechnical Engineer to perform the required earthwork geotechnical testing, inspection and observation as specified within the contents of the Contract Documents. The cost for the geotechnical testing, inspection and observation services shall be borne by the Contractor. A copy of all tests and reports shall be forwarded to the Engineer

within four (4) days after any specific service is conducted. The Contractor shall bear the cost of retest and re-inspection of re-worked material due to faulty work.

1.09 STANDARDS FOR SOIL CLASSIFICATION, PROPERTIES AND TESTS

A. Earthwork and Embankment:

1. Classification - ASTM D 2487.

2. Physical Properties - ASTM D 854, D 2216.

3. Compaction - Modified Proctor ASTM D 1557-91.

B. Backfill for Trench:

1. Classification - ASTM D 2487.

2. Compaction - Modified Proctor ASTM D 1557-91.

3. Field Density Test - ASTM 1556-82; D 2937-83, D 2922-81 (as approved by Engineer).

C. Structural Fill and Backfill:

1. Classification - ASTM D 2487.

2. Attenberg Limits - PlastiOwner Index and Liquid Limit ASTM D 4318.

3. Compaction - Modified Proctor ASTM D 1557-91.

4. Physical Properties - ASTM D 854, D 2216.

5. Field Density Test - ASTM D 1556-82, D 2937-83, D 2922-81 (as approved by Engineer).

D. Controlled Fills:

1. Classification - ASTM D 2487.

2. Physical Properties - ASTM D 854, D 2216.

3. Compaction - Modified Proctor ASTM D 1557-91.

4. CBR - ASTM D 1883 (R-Value - ASTM 2844).

5. Field Density Test - ASTM D 1556-82, D 2937-83, D 2922-81 (as approved by Engineer).

E. Earth Embankments and Berms:

1. Classification - ASTM D 2487.

2. Physical Properties - ASTM D 854, D 2216.

3. Compaction - Modified Proctor ASTM D 1557-91

4. CBR - ASTM D 1883.

5. Field Density Test - ASTM D 1556-82, D 2937-83, D 2922-81 (as approved by Engineer).

F. Borrow:

1. Classification - ASTM D 2487.

2. Other properties - as determined by requirements at point of use.

G. Pipe Trenches:

1. Classification - ASTM D 2487.

2. Physical Properties - ASTM D 854, D 2216.

3. Compaction - Modified Proctor ASTM D 1557-91.

4. CBR - ASTM D 1883.

5. Field Density Test - ASTM D 1556-82, D 2937-83, D 2922-81 (as approved by Engineer).

1.10 COMPACTION

The maximum dry density, optimum moisture content and field density of each soil type used in the controlled compacted fill shall be determined as stated in Section 1.09 above.

1.11 INSPECTION

Observation and compaction tests shall be obtained by the Geotechnical Engineer employed by the Contractor during the filling and compacting operations.

1.12 GUARANTEE

Work required by this Section shall be subject to the guarantee requirements stated in the Conditions of the Contract and included in the Performance/Maintenance Bond.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Controlled Fill Material: Materials for controlled fill shall consist of any material imported or excavated from the *cut areas* that, in the opinion of the Engineer, is appropriate for use in constructing fills. The material shall contain no rocks or hard lumps greater than 12 inches in size and shall contain at least 40 percent of material smaller than ¾-inch in size. Materials greater than 6 inches in size shall be placed by the Contractor in windrows on a clean, over excavated, or unyielding compacted fill or firm natural ground surface. Select native or imported granular soil (sand equivalent greater than 30) shall be placed and thoroughly flooded over and around all windrowed rock, such that voids are filled. Windrows of oversize material should be staggered so that successive strata of

oversized material are not in the same vertical plane. No nesting or rocks shall be permitted. No material of a perishable, spongy, or otherwise of an improper nature shall be used in filling.

Material placed within 24 inches of rough grade shall be select material that contains no rocks or hard lumps greater than 6 inches in size and that swells less than 3 percent when compacted as hereinafter specified for compacted fill and when subjected to an axial pressure of 160 PSF, if not specified in the Geotechnical report.

Representative samples of material to be used for fill shall be tested in the laboratory by the Geotechnical Engineer in order to determine the maximum density, optimum moisture content, sand equivalent, and classification of the soil. In addition, the Geotechnical Engineer shall determine the approximate bearing value of a recompacted saturated sample by direct shear tests or other tests applicable to the particular soil.

During grading operations, soil types other than those analyzed in the report of the soil investigation may be encountered by the Contractor. The Geotechnical Engineer shall be consulted to determine the suitability of these soils. The Contractor shall bear the expenses of the Geotechnical investigation.

B. Structural Fill Material: Materials shall consist of crushed rocks, Class 2 Base, granular sand, decomposed granite (crusher fines) or fine gravel either imported or manufactured from excavated onsite rocky material.

The crushed aggregate, granular sand, decomposed granite (crusher fines) or fine gravel shall be uniformly graded. The following gradations shall apply:

1. Granular Sand:

Clean granular sand free of clay, shale and deleterious material. Sand shall be compacted to 95 percent of maximum density at optimum water content per ASTM D 1557 unless otherwise noted on the Plans. The material shall conform to a sand equivalent of 30 or greater. The maximum amount of material passing the Number 200 sieve shall be 5 percent. The sand shall conform to the following gradation percentages:

SIEVE SIZE	GRANULAR SAND % PASSING
3/8”	100
No. 4	98-90
No. 8	90-75
No. 10	75-60
No. 16	60-50
No. 30	50-38
No. 40	38-29
No. 50	29-19
No. 100	19-7
No. 200	5-0

The Contractor shall supply a 5-gallon sample of sand material to the material testing laboratory within five (5) days after the Notice to Proceed is issued. The gradation, sand equivalent and maximum density of the sand material shall be determined. The test results shall be forwarded to the Engineer. The cost of testing shall be incurred by the Contractor. The gradation of the granular sand shall be determined and the test results forwarded to the Engineer prior to the

delivery of the granular sand material to the Site. Prior to the placement of sand the native subbase grade shall be checked and approved by the Engineer.

Crusher fines shall be allowed to be utilized in lieu of sand if approved by the Engineer.

2. Crusher Fines:

Crusher fines shall consist of decomposed granite indigenous to the Imperial Valley. Crusher fines utilized for this project shall conform to the following gradation requirements:

SIEVE SIZE	PERCENT PASSING
5/8”	100
No. 4	80-100
No. 8	50-85
No. 30	30-50
No. 200	4-15

The sand equivalent shall be 20 or greater.

The Contractor shall supply a five-gallon sample of crusher fines material to the material testing laboratory within five (5) days after the Notice to Proceed is issued. The Gradation and Maximum Density of the crusher fines material shall be determined. The test results shall be forwarded to the Engineer for approval prior to the delivery of the material to the Site. The cost of the testing shall be incurred by the Contractor.

3. Fine Gravel:

Clean fine gravel free of clay, shale, and deleterious material. Fine gravel shall be compacted with a plate compactor with one pass in maximum 1-foot lifts. Additional lifts shall not be added until previous lifts shall have been passed over by the plate compactor. The maximum amount of material passing the ¼” Sieve shall be 2 percent. The fine gravel shall conform to the following gradation percentages:

SIEVE SIZE	PERCENT PASSING
3/8”	100
1/4”	0-2

The Contractor shall supply a five-gallon sample of fine gravel material to the material testing laboratory within five (5) days after the Notice to Proceed is issued. The Gradation and Maximum Density of the fine gravel material shall be determined. The test results shall be forwarded to the Engineer for approval prior to the delivery of the material to the Site. The cost of the testing shall be incurred by the Contractor.

4. Class 2 Base:

The Class 2 Base material shall conform to Caltrans Section 26, Latest Edition, for 25mm maximum base material. The gradation requirements are as follows:

SIEVE SIZE	CLASS 2 BASE % PASSING
1”	100
¾”	87-100
No. 4	30-65
No. 30	5-35
No. 200	0-12

The sand equivalent shall be 25 or greater. An angular aggregate is to be used. Class 2 Base material shall be compacted to 95 percent of maximum density according to ASTM D 1557, unless otherwise noted on the Plans or Details. The tolerance for the Class 2 Base between design subgrade elevation and actual subgrade elevation as constructed in the field shall be plus or minus 0.02 feet as referenced from the design subgrade. Prior to the placement of Class 2 Base, the native subbase grade shall be checked and approved by the Engineer. The native subbase grade shall be within plus or minus 0.05 feet of native subbase design grade prior to the placement of Class 2 Base.

The Contractor shall supply a 5-gallon sample of the Class 2 Base to the material testing laboratory within four (4) days of the Notice to Proceed. The material shall be delivered to the testing laboratory to determine the maximum density, gradation, R-value, sand equivalent and durability index of the Class 2 Base. A copy of the test results shall be forwarded to the Engineer by the Geotechnical Consultant for review. The gradation of the Class 2 Base shall be determined and the test results forwarded to the Engineer for approval prior to the delivery of the Class 2 Base material to the Site. *Class 2 Base utilizing recycled materials shall not be allowed*.

C. Structural Backfill Material: Structural Backfill Material shall consist of the same material listed with the Structural Fill Material item above.

D. Special Crushed Rock Bedding and Structure Foundation: When groundwater is encountered in the excavation and/or where indicated on the Plans, the material in the bottom of the trench or excavation shall be removed to a depth directed by the Geotechnical Engineer and replaced with 3/4-inch maximum crushed rock bedding or 1” round rock bedding. The rock beddings shall be installed and compacted per these Specifications. The 3/4-inch maximum crushed rock and 1” round rock materials shall be approved by the Geotechnical Engineer before use.

The bottom and sidewalls of the trench shall be covered with a geotextile. The geotextile fabric shall extend to the top of the pipe zone material on both sides of the trench excavation, and cover the top of the crushed rock and or 1-inch round rock.

1. 3/4-Inch Maximum Crushed Rock

Crushed rock shall be the product of crushing rock or gravel. Fifty percent (50%) of the particles by weight retained on a 3/8-inch sieve shall have their entire surface area composed of faces resulting from fracture due to mechanical crushing. Not over 5% shall be particles that show no faces resulting from crushing. Less than 10% of the particles that pass the 3/8-inch sieve and are retained on the No. 4 sieve shall be waterworn particles. Gravel shall not be added to the crushed rock. Crushed rock (3/4”) shall have the following gradation:

SIEVE SIZES	3/4-INCH MAX. CRUSHED

	ROCK % PASSING
1”	100
3/4”	90-100
1/2”	30-60
3/8”	0-20
No. 4	0-5
No. 8	-

The ¾-inch maximum crushed rock shall be compacted with a plate compactor in one pass in maximum 1 foot lifts. Additional lifts shall not be added until previous lifts shall have been passed over by the plate compactor.

The Contractor shall supply a five-gallon sample of the ¾-inch maximum crushed rock material to the material testing laboratory within four (4) days of the Notice to Proceed. The Gradation and Sand Equivalent of the crushed rock shall be determined. The tests results shall be forwarded to the Engineer for approval prior to the delivery of the material to the Site. The cost of the testing shall be incurred by the Contractor.

2. 1” Round Rock

The 1-inch round rock material shall conform to the following gradation requirements:

SIEVE SIZES	1-INCH ROUND ROCK % PASSING
1-1/2”	100
1”	96
3/4”	79
1/2”	25
3/8”	1

The 1-inch round rock shall be compacted with a plate compactor in one pass in maximum 1 foot lifts. Additional lifts shall not be added until previous lifts shall have been passed over by the plate compactor.

The Contractor shall supply a five-gallon sample of the 1-inch round rock material to the material testing laboratory within four (4) days of the Notice to Proceed. The Gradation of the round rock shall be determined. The tests results shall be forwarded to the Engineer for approval prior to the delivery of the material to the Site. The cost of the testing shall be incurred by the Contractor.

PART 3 - EXECUTION

3.01 GENERAL

The Work performed under this Specification shall be constructed to the lines, grades, elevations, slopes and cross-sections indicated on the Plans, specified herein, and/or directed by the Owner. Slopes, graded surfaces, and drainage features shall present a neat uniform appearance upon completion of the Work.

It shall be the Contractor's responsibility (1) to maintain adequate safety measures and working conditions; and (2) to take all measures necessary during the performance of the Work to protect the entire project area and adjacent properties which would be affected by this Work from storm damage, flood hazard, caving of trenches and embankments, and sloughing of material, until final acceptance by the Owner. It shall be the Contractor's responsibility to maintain completed areas until the entire project area is in satisfactory compliance with the job specification.

Utility lines and structures indicated on the Plans which are to remain in service shall be protected by the Contractor from any damage as a result of his/her operation. Where utility lines or structures not shown on the Plans are encountered, the Contractor shall report them to the Owner before proceeding with the Work. The Contractor shall bear the cost of repair or replacement of any utility lines or structures which are broken or damaged by his/her operations.

3.02 REMOVALS, CLEARING AND GRUBBING

A. Clearing: Clearing consists of the complete removal of objectionable materials and obstructions above and below the ground surface including tree stumps, brush, grass, vegetative matter and other objectionable materials within the project limits. All brush and organic material shall be removed before placing any earth fills. It shall be the Contractor's responsibility to save and protect all trees that lie outside the construction area.

B. Grubbing: Grubbing consists of the complete removal of stumps, including tap roots or lateral roots 1-1/2 inches or more in diameter, and the removal of brush, grass or weeds to depths below the natural ground as specified herein. Stumps shall be grubbed to a depth of 3 feet and grass or weeds shall be grubbed to a depth of 6 inches below the natural ground surface, or to the depths as determined in the field by the Engineer at the time of construction.

C. Protection: Existing items not designated to be demolished or removed shall be protected from damage. Any such item damaged by the Contractor shall be restored or replaced immediately at the Contractor's expense.

D. Debris and Waste Material: All debris and waste material resulting from demolition, clearing and grubbing shall be removed from the site and disposed of by the Contractor.

3.03 DUST CONTROL

The Contractor shall take all steps possible to prevent and reduce dust arising from the construction activity. Section 01560 Project Environmental Controls elaborates on dust control requirements.

3.04 CARE OF DRAINAGE WATER

Contractor shall take care of drainage water from the construction operations, and of stormwater and/or wastewater reaching the construction area from any source, so that damage is not incurred to the excavation, pipe, or structures. The Contractor shall be responsible for any damages to persons or property on or off the Site due to such drainage water or to the interruption or diversion of such stormwater or wastewater on account of his/her operation.

Such grading shall be done as may be necessary to prevent surface water from flowing into excavations, and any water accumulating therein shall be removed by pumping or by other reviewed methods.

Protection of the site during construction shall be the responsibility of the Contractor. Completion of a portion of the project shall not preclude that portion or adjacent areas from the requirements for site protection until such time as the entire project is complete.

3.05 EXCAVATION

A. General: The Contractor shall perform all excavation necessary or required as illustrated on the Plans. The excavation shall include the removal and disposal of all earth materials of whatever nature encountered, which shall include both rock excavation and common excavation when both are present, and shall include the furnishing, placing, and maintaining of shoring and bracing necessary to safely support the sides of the excavations. See Technical Specifications Section 02150 Sheeting, Shoring, and Bracing.

B. Excavation for Structures: Structure excavation shall include the removal of all materials of whatever nature encountered, including all obstructions of any nature that would interfere with the proper execution and completion of the Work. The removal of such materials shall conform to the lines and grades shown on the Plans and/or herein specified. Temporary structure excavations shall at all times conform to the Requirements of the State of California, Division of Occupational Health and Safety, and pertinent requirements contained in referenced Geotechnical Investigation Report and Specification Section 02150 - Sheeting, Shoring and Bracing.

Continuous wall and isolated footings shall be underlain by a minimum compacted controlled fill thickness to a minimum 1.5 times the footing width or greater if indicated in the referenced Geotechnical Investigation Report or as required by the Plans. This zone of over-excavation, scarification, and recompaction shall extend a minimum of five feet (5') beyond the footing lines unless otherwise illustrated on the Plans. Exposed native surface shall be scarified, brought to optimum moisture content, and compacted to a minimum of 95 percent relative compaction if required by the Geotechnical Investigation Report or the Plans.

All surfaces to receive concrete slabs-on-grade shall be underlain by a minimum compacted controlled fill thickness of 18 inches or greater if indicated in the referenced Geotechnical Investigation Report or as required by the Plans. This shall be accomplished by combination of over-excavation and recompaction to 95% of relative compaction or as required by the Geotechnical Investigation Report or as required by the Plans.

Contingent upon locations, all surfaces to receive compacted fill shall be scarified, brought to near optimum moisture content, and compacted to required percentage of relative compaction as specified herein unless otherwise indicated on the Plans.

Rough grade excavations for structures and footings will be inspected by the Geotechnical Engineer to verify that the excavations extend into satisfactory soils and are free of loose and disturbed materials.

Foundation for tanks, pump vaults or subsurface chambers shall have structural fill material extending 12 inches, minimum, below the structural base slab to native material, which has been scarified and compacted to 95% relative compaction unless otherwise indicated on the Plans.

3.06 CONTROLLED FILL

A. General: Controlled fill shall consist of native material, granular sand, Class 2 Base, crusher fines or other material as indicated on the Plans. The subbase grade shall be excavated to within plus or minus 0.05 feet of design grade prior to the placement of controlled fill. The design subbase grade shall be field verified and approved by the

Engineer prior to the placement of the controlled fill material. The Engineer shall determine the number and location of points to check for the subbase grade elevation compliance. Prior to the Engineer's inspection of the subbase grade, the Contractor shall establish bluetop stakes on a 20-foot by 20-foot grid across the area controlled fill is to be placed.

If the controlled fill consists of native material it shall be placed in maximum 1-foot lifts and compacted to 90 percent of maximum density at optimum water content per ASTM D 1557. Additional native soil lifts shall not be placed until previous lifts have attained the specified compaction requirement and are approved by both the on-site geotechnical representative and the Engineer.

Granular sand, Class 2 Base and crusher fine controlled fill material shall be placed in maximum 8-inch lifts and compacted to 95 percent of maximum density at optimum water content per ASTM D 1557. Additional granular sand, Class 2 Base or crusher fine lifts shall not be placed until previous lifts have attained the specified compaction requirement and are approved by both the on-site geotechnical representative and the Engineer.

B. Preparing Areas To Be Filled: All vegetation and objectionable material shall be removed by the Contractor from the surface upon which the fill is to be placed and any loose and porous soils shall be removed or compacted to a depth specified by the Geotechnical Engineer. The surface shall then be plowed or scarified to a minimum depth of 6 inches until the surface is free from uneven features that would tend to prevent uniform compaction by the equipment to be used.

When placing fill in horizontal lifts adjacent to areas sloping steeper than 5:1 (horizontal:vertical), horizontal keys and vertical benches shall be excavated into the adjacent slope area. Keying and benching shall be sufficient to provide at least 6-foot wide benches and a minimum of 4 feet vertical bench height within the firm natural ground, firm bedrock or engineered compacted fill. No compacted fill shall be placed in an area subsequent to keying and benching until the area has been reviewed by the Geotechnical Engineer. Material generated by the benching operation shall be moved sufficiently away from the bench area to allow for the review of the horizontal bench prior to placement of fill.

After the foundation for the fill has been cleared, plowed or scarified, it shall be disced or bladed by the Contractor until it is uniform and free from large clods, brought to the proper moisture content and compacted as specified.

C. Placing, Spreading and Compacting Fill Material: The fill material shall be placed by the Contractor in thin layers that when compacted shall not exceed 8 inches for granular sand, Class 2 Base and crusher fines and 12 inches deep for native material. Each layer shall be spread evenly and shall be thoroughly mixed during the spreading to obtain uniformity of material in each layer.

When the moisture content of the fill material is below that required by the Geotechnical Engineer, water shall be added by the Contractor until the moisture content is as required for the specified compaction.

When the moisture content of the fill material is above that required by the Geotechnical Engineer, the fill material shall be aerated by the Contractor by blading, mixing, or other satisfactory methods until the moisture content is as required for the specified compaction.

After each layer has been placed, mixed and spread evenly, it shall be thoroughly compacted by the Contractor to the specified density. Compaction shall be accomplished by sheepsfoot rollers, vibratory rollers, multiple-wheel pneumatic-tired rollers or other types of acceptable compacting equipment. Equipment shall be of such design that it shall be able to compact the fill to the specified density. Compaction shall be continuous over the entire area and the equipment shall make sufficient passes over the material to ensure that the desired density has been obtained.

Compacted fill slopes shall be overbuilt and cut back to grade, exposing the firm, compacted inner core. The slopes shall be overbuilt a minimum of five feet (5'). If the desired compaction is not achieved, the existing slope shall be overexcavated and reconstructed. The amount of overbuilding shall be increased until the desired compaction is achieved on the slope. The Contractor shall provide thorough mechanical compaction to the outer edge of the overbuilt slope surface. There shall be no excessive loose soil on the slopes.

The Contractor shall provide and maintain adequate erosion control facilities during the construction of the fill areas. The erosion control facilities shall be maintained in optimum condition until the permanent drainage system and vegetation is complete. The facilities shall be inspected following significant rainfall, repairs made and excess sediment removed. It shall be the Contractor's responsibility to prevent the discharge of sediment off-site or to adjacent watercourses.

3.07. STRUCTURE FILL AND STRUCTURE BACKFILL MATERIAL

A. Placement of Structure Backfill: Before beginning backfilling, all foreign material, including water, shall be removed from the space to be backfilled and the area to be backfilled shall be inspected and approved by the Geotechnical Engineer. Sloping sides of the excavated space shall be stepped to prevent wedging action of the backfill against the structure. No backfill shall be placed around or upon any structure until it is proven that the concrete has attained satisfactory strength in accordance with the Division 3 of Technical Specifications and that the structure as a whole is adequate to receive backfill. The compressive strength shall be determined by tests on representative cylinders cured under conditions similar to those prevailing at the site.

B. General: Structure fill and structure backfill shall consist of granular sand, Class 2 Base, crusher fines or other material as indicated on the Plans. The subbase grade shall be excavated to within plus or minus 0.05 feet of design grade prior to the placement of structure fill and structure backfill. The design subbase grade shall be field verified and approved by the Engineer prior to the placement of the structure fill or structure backfill material. The Engineer shall determine the number and location of points to check for the subbase grade elevation compliance. Prior to the Engineer's inspection of the subbase grade the Contractor shall establish bluetop stakes on a 20-foot by 20-foot grid across the area which structure backfill is to be placed.

Granular sand, Class 2 Base and crusher fine structure fill and structure backfill material shall be placed in maximum 8-inch lifts and compacted to 95 percent of maximum density at optimum water content per ASTM D 1557. Additional granular sand, Class 2 Base or crusher fine lifts shall not be placed until previous lifts have attained the specified compaction requirement and are approved by both the on-site geotechnical representative and the Engineer.

C. Placing, Spreading and Compacting Fill Material: The structural fill and structural backfill material shall be placed by the Contractor in thin layers that when compacted

shall not exceed 8 inches. Each layer shall be spread evenly and shall be thoroughly mixed during the spreading to obtain uniformity of material in each layer.

When the moisture content of the fill material is below that required by the Geotechnical Engineer, water shall be added by the Contractor until the moisture content is as required for the specified compaction.

When the moisture content of the fill material is above that required by the Geotechnical Engineer, the fill material shall be aerated by the Contractor by blading, mixing, or other satisfactory methods until the moisture content is as required for the specified compaction.

After each layer has been placed, mixed and spread evenly, it shall be thoroughly compacted by the Contractor to the specified density. Compaction shall be accomplished by sheepsfoot rollers, vibratory rollers, multiple-wheel pneumatic-tired rollers or other types of acceptable compacting equipment. Equipment shall be of such design that it shall be able to compact the fill to the specified density. Compaction shall be continuous over the entire area and the equipment shall make sufficient passes over the material to ensure that the desired density has been obtained.

Compacted fill slopes shall be overbuilt and cut back to grade, exposing the firm, compacted inner core. The slopes shall be overbuilt a minimum of five feet (5'). If the desired compaction is not achieved, the existing slope shall be overexcavated and reconstructed. The amount of overbuilding shall be increased until the desired compaction is achieved on the slope. The Contractor shall provide thorough mechanical compaction to the outer edge of the overbuilt slope surface. There shall be no excessive loose soil on the slopes.

The Contractor shall provide and maintain adequate erosion control facilities during the construction of the fill areas. The erosion control facilities shall be maintained in optimum condition until the permanent drainage system and vegetation is complete. The facilities shall be inspected following significant rainfall, repairs made and excess sediment removed. It shall be the Contractor's responsibility to prevent the discharge of sediment off-site or to adjacent watercourses.

3.08 SUITABLE MATERIAL AND WASTE EXCAVATION

A. General: Suitable material or waste excavation consists of native material. The subbase grade shall be excavated to within plus or minus 0.05 feet of design grade prior to the placement of suitable material or waste excavation material. The design subbase grade shall be field verified and approved by the Engineer prior to the placement of the suitable material or waste excavation material. The Engineer shall determine the number and location of points to check for the subbase grade elevation compliance. Prior to the Engineer's inspection of the subbase grade the Contractor shall establish bluetop stakes on a 20-foot by 20-foot grid across the area suitable material or waste excavation material is to be placed.

The suitable material or waste excavation material shall be placed in maximum 1-foot lifts and compacted to 90 percent of maximum density at optimum water content per ASTM D 1557. Additional suitable material or waste excavation material lifts shall not be placed until previous lifts have attained the specified compaction requirement and are approved by both the on-site geotechnical representative and the Engineer.

B. Placing, Spreading and Compacting Suitable Material and Waste Excavation Material: The suitable material and waste excavation material shall be placed by the Contractor in

1-foot lifts. Each layer shall be spread evenly and shall be thoroughly mixed during the spreading to obtain uniformity of material in each layer.

When the moisture content of the fill material is below that required by the Geotechnical Engineer, water shall be added by the Contractor until the moisture content is as required for the specified compaction.

When the moisture content of the fill material is above that required by the Geotechnical Engineer, the fill material shall be aerated by the Contractor by blading, mixing, or other satisfactory methods until the moisture content is as required for the specified compaction.

After each layer has been placed, mixed and spread evenly, it shall be thoroughly compacted by the Contractor to the specified density. Compaction shall be accomplished by sheepsfoot rollers, vibratory rollers, multiple-wheel pneumatic-tired rollers or other types of acceptable compacting equipment. Equipment shall be of such design that it shall be able to compact the fill to the specified density. Compaction shall be continuous over the entire area and the equipment shall make sufficient passes over the material to ensure that the desired density has been obtained.

Compacted fill slopes shall be overbuilt and cut back to grade, exposing the firm, compacted inner core. The slopes shall be overbuilt a minimum of five feet (5'). If the desired compaction is not achieved, the existing slope shall be overexcavated and reconstructed. The amount of overbuilding shall be increased until the desired compaction is achieved on the slope. The Contractor shall provide thorough mechanical compaction to the outer edge of the overbuilt slope surface. There shall be no excessive loose soil on the slopes.

The Contractor shall provide and maintain adequate erosion control facilities during the construction of the fill areas. The erosion control facilities shall be maintained in optimum condition until the permanent drainage system and vegetation is complete. The facilities shall be inspected following significant rainfall, repairs made and excess sediment removed. It shall be the Contractor's responsibility to prevent the discharge of sediment off-site or to adjacent watercourses.

3.09 ESTABLISHMENT OF SUBBASE GRADE, SUBGRADE OR FINISH GRADE

Finish Grade is defined as the finish surface grade. For instance, the top of an A.C. or P.C.C. paved surface is referred to as finish grade.

Subgrade is defined as the grade of the material beneath the finish surface. For instance, the top of Class 2 Base grade beneath an A.C. or P.C.C. paved surface is referred to as subgrade.

Subbase is defined as the grade of the material beneath the base material. For instance, the top of native material beneath the Class 2 Base subgrade material of an A.C. or P.C.C. paved roadway is the subbase grade.

Finish grade surfaces are to be graded to within plus or minus 0.02 feet from design grade as illustrated on the Grading Plans. The Contractor shall place bluetop stakes on a 20-foot x 20-foot grid across the top of the finish grade surface during final grading. A bluetop stake is defined as a stake placed at the finish grade elevation within the tolerance of plus or minus 0.02 feet of finish grade. The Engineer shall obtain elevations across finish grade surfaces at locations determined by the Engineer prior to accepting and approving the finish grade surfaces. The Contractor shall rework areas not conforming to the finish surface grade tolerance as required. Work items to occur after the establishment of finish grade shall not occur until the Engineer has approved the finish grade.

Subgrade surfaces are to be graded to within plus or minus 0.02 feet from design grade as illustrated on the Grading Plans. Bluetop stakes shall be placed on a 20-foot x 20-foot grid pattern across rectangular or square facilities such as parking lots and access roads. The Engineer shall obtain elevations across the subgrade surfaces at locations determined by the Engineer prior to accepting and approving the subgrade surfaces. The Contractor shall rework areas not conforming to the subgrade tolerance as required. Work items to occur after the establishment of subgrade shall not occur until the Engineer has approved the finish grade.

Subbase surfaces are to be graded to within plus or minus 0.05 feet of subbase design grade as illustrated on the Grading Plans. Bluetop stakes shall be placed on a 20-foot x 20-foot grid pattern across rectangular or square facilities such as parking lots, access roads, sludge beds, etc. The Engineer shall obtain elevations across the subbase surfaces at locations determined by the Engineer prior to accepting and approving the subbase surfaces. The Contractor shall rework areas not conforming to the subbase design grade tolerance as required. Work items to occur after the establishment of subbase grade shall not occur until the Engineer has approved the subbase grade.

3.10 COMPACTION TEST SCHEDULE

Compaction test(s) shall be conducted as applicable. Specific tests shall be noted in the Special Conditions of the Specifications. The following list of tests shall be conducted as applicable:

NO.	ITEM	FREQUENCY*
1	Recompaction of scarified native subgrade surface beneath base material installation area.	Every 100 square feet
2	Compaction test for each 12 inches (vertical) of loose sand placed in trench.	Every 200 lineal feet
3	Compaction test for each 12 inches (vertical) of native soil placed in trench.	Every 200 lineal feet
4	Compaction test for Class 2 Base in the area of the roadway or parking lot	Every 100 square feet
5	Compaction test for Asphalt Pavement in the area of the roadway or parking lot	Every 100 square feet
6	Compaction tests for native soil shoulder backing.	Every 100 square feet of shoulder backing area
7	Compaction Tests for the granular sand material /Class 2 Base beneath P.C.C. barrier curb.	Every 100 feet of barrier curb

8	Compaction Tests for the granular sand material /Class 2 Base beneath flatwork including P.C.C. sidewalk, gutter, slab, site furnishing pads, etc.	Every 100 square feet of flat work
9	Compaction tests for the Class 2 Base beneath structures and for the backfill around the structures.	Every 100 square feet of base/backfill area at each lift
10	Compaction beneath and surrounding the excavation zone of Facility and Equipment slab	Every 80 square feet of concrete pad for each lift.
11	Building Pad granular sand compaction tests. There is 3 feet of granular soil to be placed beneath the building slab in 8-inch lifts. Obtain compaction tests for each 8-inch lift.	Every 80 square feet of concrete pad for each lift.
12	Building Pad granular sand compaction tests. There is 3 feet of granular soil to be placed beneath the building slab in 8-inch lifts. Obtain compaction tests for each 8-inch lift.	Every 80 square feet of concrete pad for each lift.

* Testing locations shall be randomly determined at the project site by the Geotechnical Tester and Construction Manager.

3.11. CLEAN-UP

Upon completion of Work in this Section, all rubbish and debris shall be removed from the site. All construction equipment and implements of service shall be removed and the entire area involved shall be left in a clean, neat, and acceptable condition.

END OF SECTION 02200

SECTION 02221 - TRENCHING, BACKFILLING AND COMPACTING

PART 1 - GENERAL

1.01 DESCRIPTION

Requirements specified in the Technical and Special Conditions form a part of this Section. The Work of this Section includes all labor, machinery, construction equipment and appliances to perform in a professional manner all trench excavation and backfill work illustrated on the Plans and herein specified.

A. Principal items included:

1. Trench excavation, backfill and compaction.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 02200 – Earthwork

B. Section 02150 – Sheeting, Shoring and Bracing

C. Piping & Conduit Work specified in other Sections

1.03 SAFETY

The Contractor shall be familiarized with, and shall at all times conform to all applicable regulations of "Excavations, Trenching, and Shoring" of OSHA Safety and Health Regulations for Construction, "General Construction Safety Orders" and "Trench Construction Safety Orders" of the State of California, Department of Industrial Relations, Division of Occupational Health and Safety.

1.04 INSPECTION AND CONTROL

The Contractor shall provide inspection and testing by a Geotechnical Engineer approved by the Engineer engaged and paid for by the Contractor. In this regard, a Geotechnical Engineer may be engaged by the Owner, who shall act as the direct representative of the Owner in geotechnical work, to perform inspection of the removal and replacement of unsuitable materials, all excavations, and the placement and compaction of all fills and backfills within the limits of earthwork on this Project. Costs for all such inspections and tests will be paid by the Contractor, and Contractor shall bear the cost of retest and re-inspection of reworked fills and backfills due to compaction test failure.

1.05 REQUIREMENTS

A. General:

1. The Work performed under this Specification shall be constructed to the lines, grades, elevations, slopes and cross-sections indicated on the Plans, specified herein, and/or directed by the Engineer in writing. Slopes, graded surfaces, and drainage features shall present a neat, uniform appearance upon completion of the Work.

2. It shall be the Contractor's responsibility (1) to maintain adequate safety measures and working conditions; and (2) to take all measures necessary during the performance of the Work to protect the entire project area and adjacent properties which would be affected by this Work from storm damage, flood

hazard, caving of trenches, cavings of excavations, and embankments, and sloughing of material, until final acceptance by the Owner. It shall be the Contractor's responsibility to maintain completed areas in good condition until the entire project area is in satisfactory compliance with the Project Specifications.

3. Contractor shall be responsible for the excavation and disposition of unsuitable or surplus material by approved means of conveyance away from the working area.

B. Protection of Existing Utilities:

1. Utilities: Unless otherwise illustrated on the Plans or stated in the Specifications, all utilities, both underground or overhead, shall be maintained in continuous service throughout the entire contract period. The Contractor shall be responsible and liable for any damages to or interruption of service caused by the construction.

If the Contractor desires to simplify his operation by temporarily or permanently relocating or shutting down any utility or appurtenance, he shall make the necessary arrangements, agreements and approvals with the utility purveyor, Owner and Engineer and shall be completely responsible for all costs concerned with the relocation or shutdown and reconstruction. All property shall be reconstructed in its original or new location as soon as possible and to a condition at least as good as its previous condition. This cycle of relocation or shutdown and reconstruction shall be subject to inspection and approval by the Engineer, Owner and the utility purveyor.

The Contractor shall be entirely responsible for safeguarding and maintaining all conflicting utilities that are illustrated on the Plans. This includes overhead wires and cables and their supporting poles whether they are inside or outside of the open trench. If, in the course of work, a conflicting utility line that was not illustrated on the Plans is discovered, it shall be brought to the immediate attention of the Engineer for a determination regarding alternatives to the conflict.

2. Building, Foundations and Structures: Where trenches are located adjacent to buildings, foundations and structures, the Contractor shall take all necessary precaution against damage to them. The Contractor shall be liable for any damage caused by the construction except where authorized in the Special Conditions or in writing by the Engineer. Water settling of backfill material in trenches adjacent to structures will not be permitted.

3. Electronic, Telephonic, Telegraphic, Electrical, Oil and Gas Lines: These underground facilities shall be adequately supported by the Contractor. Support for plastic pipe shall be continuous along the bottom of the pipe. Support for metal pipe and electrical conduit may be continuous or nylon webbing may be used for suspension at no greater than ten foot (10') intervals. The Contractor shall avoid damaging the plastic pipe, pipe ways or conduits during trench backfilling and during foundation and bedding placement.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Granular Sand Material: Granular sand material shall consist of imported granular sand complying with Section 02200, of the specifications.

B. Crusher Fines: Crusher fines material shall consist of imported decomposed granite complying with Section 02200, of the specifications.

C. Class 2 Base Material: Class 2 Base material shall consist of imported virgin (not recycled) Class 2 Base complying with Section 02200, of the Specifications.

D. Crushed Rock Bedding: Crushed rock bedding shall consist of imported rock complying with Section 02200, of the Specifications.

E. 1-inch Round Rock: 1-inch Round Rock material shall consist of import rock material complying with Section 02200, of the Specifications.

F. Concrete: 5000 PSI compressive strength, minimum, as specified in Division 3, Concrete, of the Specifications.

G. Pipelines: Use materials shown on the Plans and as specified in other pertinent Sections of the Specifications.

PART 3 - EXECUTION

3.01 TRENCH EXCAVATION

A. Excavation for Trenches: Shall include the removal of all material of any nature for the installation of the pipe or facility and shall include the construction of trench shoring and stabilization measures, timbering and all necessary installations for dewatering.

B. Minimum Width of Trench: The minimum width of pipe trenches, measured at the crown of the pipe, shall not be less than 12 inches greater than the exterior diameter of the pipe, exclusive of bells and the minimum base width of such trench shall be not less than 12 inches greater than the exterior diameter of the pipe, exclusive of special structures or connections, and such minimum width shall be exclusive of all trench supports.

C. Maximum Width of Trench: The maximum allowable width of trench for all pipelines measured at the top of the pipe shall be the outside diameter of the pipe (exclusive of bells or collars) plus 16 inches, and such maximum shall be inclusive of all timbers. A trench wider than the outside diameter plus 16 inches may be used without special bedding if the Contractor, at his expense, furnishes pipe of the required strength to carry the additional trench load. Such modifications shall be submitted for the Engineer's review. Whenever such maximum allowable width of trench is exceeded for any reason, except as provided for on the Plans or in the Specifications, or by the written direction of the Engineer, the Engineer may, at its discretion, require that the Contractor, at his own expense for all labor and materials, cradle the pipe in 5,000 PSI compressive strength concrete, or other approved pipe bedding.

D. Maximum Length of Open Trench: Except by special permission by the Engineer only that amount of open trench shall be permitted, which shall allow for that amount of pipeline construction, including excavation, construction of pipeline, and backfill in any one location, which can be completed in one day; however, maximum length of open trench shall never exceed 600 feet. This length includes open excavation, pipe laying and appurtenant construction and backfill which has not been temporarily resurfaced.

E. Trench Side Slopes:

1. Temporary trench excavations shall at all times conform to the safety requirements hereinbefore specified in Section entitled "Safety".

2. Loose cobbles or boulders shall be removed from the sides of the trenches before allowing workmen into the excavation, or the trench slopes must be protected with screening or other methods. Trench side slopes shall be kept moist during construction to prevent local sloughing and raveling. Surcharge loads due to construction equipment shall not be permitted within 10 feet of the top of any excavated slope.

3. If the Contractor elects to shore or otherwise stabilize the trench sides, he shall file with the Engineer copies of drawings for same prepared, signed and stamped by a Civil Engineer duly registered in the State of California before commencing excavation.

F. Excess Trench Excavation: If any trench, through the neglect of the Contractor, is excavated below the bottom grade required, it shall be refilled to the bottom grade, at the Contractor's expense for all labor and material, with granular sand material compacted to a firm stable foundation.

3.02 BRACING TRENCHES

The sides of the trenches shall be supported with plank sheeting and bracing in such a manner as to prevent caving of the sides of the trench. Space left by withdrawal of sheeting or shoring shall be filled completely with dry granular material blown or rammed in place. Trench shoring shall be completed per the recommendations of the Geotechnical Report and OSHA Standards.

3.03 PIPING BEDDING

The Contractor shall excavate to four inches (4") below the bells or couplings for the full width of the trench and shall place four inches (4") of granular material upon which the pipe is to be laid, unless indicated otherwise on the Plans. Construct pipe bedding as indicated on the Plans.

At pipe subgrade, if foundation soil in trench is soft, wet, spongy, unstable or does not afford solid foundation for pipe, the Contractor shall excavate as directed by the Engineer and provide stable base by excavating any unsuitable material 18" minimum below the subgrade base or as the Engineer determines is necessary for placement of pipe bedding. A filter fabric shall be placed in the trench bottom and along the trench sidewalls in the pipe zone to the top of the pipe zone material. A crushed rock material shall be placed at the bottom of the trench and sidewalls of the pipe to a point 1 foot above the pipe. The crushed rock material shall be hand tamped in 16-inch lifts along the sidewalls. The crushed rock shall be compacted with a plate compactor in minimum 6 inch lifts beneath the pipe and over the top of the pipe.

Where rock is encountered in the trench, the Contractor shall excavate to a minimum 18 inch depth below subgrade or as the Engineer determines is necessary, and shall construct a base by placing crushed rock bedding upon which a subgrade can be prepared.

Before any pipe is lowered in place, the trench bottom shall be prepared so that each pipe shall be supported for the full length of the barrel with full bearing on the bottom segment of the pipe equal to a minimum of one-half (1/2) of the pipe OD, and a width equal to the trench width. All adjustments in line and grade shall be made by scraping away or filling and tamping in under the barrel of the pipe. Wedging or blocking is not permitted.

The pipe bedding shall be compacted to a minimum of 90 or 95 percent relative compaction as hereinafter specified or as required by the Plans.

3.04 BACKFILLING PIPE TRENCHES

A. Backfilling Pipe Zone: Backfill material for the pipe zone shall consist of imported granular material or two sack cement/sand slurry as required by the Plans. Place material in the trench simultaneously on each side of the pipe for the full width of the trench and the depth of the pipe zone in layers 6 inches in depth. Each layer shall be thoroughly compacted by tamping. In all cases, backfilling of the pipe zone must be accomplished by hand. Particular attention shall be given to underside of the pipe and fittings to provide a firm support along the full length of the pipe. The pipe zone shall be considered to extend 12 inches above the top of the pipe unless otherwise illustrated on the Plans, and shall be compacted in the trench to a relative compaction of not less than 90 or 95 percent of maximum density per ASTM D 1557 as illustrated on the Plans. Care shall be taken not to damage pipe and fittings or special coatings on the pipe and fittings.

1. Use of material other than those specified shall be reviewed by the Engineer prior to use. The Contractor shall bear all cost of removal of rejected material, its hauling to an authorized disposal site, and cost of providing required material to complete the bedding and backfilling.

B. Backfilling Pipe Trench: After the pipe has been laid in the trench and has been inspected and approved, and backfilling in the pipe zone is complete and compacted, the remainder of the trench may be backfilled. The backfill material shall be granular sand or Class 2 Base as specified in Paragraph 2.01 and illustrated on the Plans. Care shall be taken to ensure that no voids remain under, around or near the pipe.

1. The Contractor shall incur the expense to remove and dispose of the excess trench excavation material displaced by the trench import material and include the costs in the bid.

C. Compaction: The maximum dry density and optimum moisture content of each soil type used in the controlled compacted fill shall be determined by ASTM D 1557-91. Field density tests shall be determined in accordance with ASTM D 1556-82, ASTM D 2937-83 and ASTM D 2922-81.

D. Placement and Compaction of Trench Backfill: The placement and compaction of all trench backfill shall be as follows:

1. Mechanically Compacted Backfill: With approval of the Engineer, backfill shall be mechanically compacted by means of tamping rollers, sheepsfoot rollers, pneumatic tire rollers, vibrating rollers, or other mechanical tampers to 90 or 95 percent relative compaction as illustrated by the Plans. Impact-type pavement breakers (stompers or hydro-hammers) shall not be permitted over any pipe. Permission to use specific compaction equipment shall not be construed as guaranteeing or implying that the use of such equipment will not result in damage to adjacent ground, existing improvements or improvements installed under the Contract. The Contractor shall make his own determination in this regard. Backfill shall be placed in horizontal layers not exceeding eight inches (8”). Each layer shall be evenly spread, the moisture content brought to near optimum condition and then tamped or rolled until the specific relative compaction has been attained. Additional backfill lifts shall not be placed until previous lifts have been satisfactorily compacted and tested and approved by the Engineer.

3.05 CENTRAL PIPELINE INSTALLATION REQUIREMENTS

A. Depth of Pipe: Unless otherwise illustrated on the Plans, all pipelines shall have coverage of at least 36 inches between the top of the pipe and the finished surface. All gravity line invert elevations and locations illustrated on the Plans are intended to be exact and any change in alignment and grade shall be reviewed in accordance with the Contract Documents to the satisfaction of the geotechnical testing representative and Engineer. All force and gravity mains shall have 1 foot vertical clearance between themselves and all other utilities. At all water main, sewer and stormwater crossings, both gravity and force mains shall have 20 linear feet of concrete encasement centered at the crossing as required by the State of California Department of Health.

B. Changes in Line and Grade: In the event obstructions not shown on the Plans, are encountered during the progress of the Work, which will require alterations to the Plans, the Engineer shall issue the necessary revisions to the Plans and order the necessary deviation from the line or grade. The Contractor shall not make any deviation from the specified line and grade without prior review and approval by the Engineer. Should any deviations in line and grade be permitted by the Engineer in order to reduce the amount of rock excavation or for other similar convenience to the Contractor, any additional costs for thrust blocks, valves, air and vacuum valve assemblies, blow-off assemblies, extra pipe footage, concrete, sewer structures, or other additional costs shall be borne by the Contractor.

1. Contractor shall include in his Bid provisions to cover any deviation from the invert grade shown on the Plans to facilitate the extra depth required to avoid possible conflicts between existing gravity pipelines and other utilities with new water, stormwater or sewer forcemains.

C. Pipe Installation:

All pipe and fittings, and accessories furnished by the Contractor shall be new material free from rust or corrosion. All piping and fittings shall be cleaned on the inside when installed and the Contractor shall take all necessary precautions to insure that the lines are kept free of any foreign matter and dirt until the work is completed. All pipes shall be carefully placed and supported at the proper lines and grades as shown on the Plans. Piping runs shown on the Plans shall be followed as closely as possible, except for minor adjustments as approved by the Engineer to avoid other piping or structural features. Bedding material shall first be placed so that the pipe is supported for the full length of the barrel with full bearing on the bottom segment of the pipe. Hunching of the pipe shall not be allowed. Pipe will be carefully inspected in the field before and after laying. If any cause for rejection is discovered in a pipe after it has been laid, it shall be subject to rejection by the Engineer. Any corrective work shall be approved by the Engineer. Pipe shall be laid true to line and grade with uniform bearing under the full length of the barrel of the pipe. Suitable excavation shall be made to receive the bell or collar which shall not bear upon the subgrade or bedding. Any pipe which is not in true alignment or shows any undue settlement after laying shall be taken up and relaid at the Contractor's expense. Pipe shall be laid upgrade with the socket ends of the pipe upgrade unless otherwise authorized by the Engineer. Pipe sections shall be laid and joined in such a manner that the offset of the inside of the pipe at any joint will be held to a minimum at the invert. The maximum horizontal offset at the invert of the pipe shall be 1% of the inside diameter of the pipe or 0.02 feet, whichever is smaller. The vertical grade shall be ± 0.02 feet of the design invert. In joining socket pipe, the spigot of each pipe shall be so seated in the socket of the adjacent pipe as to give a uniform annular space all around the pipe in the socket.

The following pipe installation items shall be required:

1. No pipe shall be laid which is damaged, cracked, checked or spalled or has any other defect deemed by the Engineer to make it unacceptable, and all such sections shall be permanently removed from the Work.

2. At all times when the Work of installing pipe is not in progress, all openings into the ends of the pipelines shall be kept tightly closed with suitable plywood or sheet metal bulkheads to prevent the entrance of animals and foreign materials and to prevent water from entering the pipe.

3. Keep the pipe trench free from water at all times and take all necessary precautions to prevent the pipe from floating due to water entering the trench from any sources. Any damage is the Contractor's full responsibility. Restore and replace the pipe to its specified conditions and grade if it is displaced due to floating.

4. All pipelines adjoining concrete structures (including manholes) shall have a flexible joint, such as sleeve transition couplings, within 36 inches from the face of such concrete structures. Flexible joints shall be installed on all pipe 4" and larger whether or not a flexible joint is illustrated on the Plans. Where the flexible joint is illustrated on the Plans, install the joint at the location indicated.

3.06 COMPACTION OF PIPE BEDDING AND BACKFILL

Unless specified in the Plans or Earthwork Specification (Technical Specification Section 02200), the following compaction test for piping shall be required.

A. One (1) compaction test for the granular sand fill pipe bedding along each 100 lineal foot of water, sewer or stormwater pipe placed for each 1 foot lift of material installed.

B. One (1) compaction test shall be obtained for each 1 foot lift of Class 2 Base material along each 100 foot section of water, sewer or stormwater pipeline installed.

C. One (1) compaction test shall be required for each 1 foot of vertical sand fill material placed along each 100 feet of water, sewer or stormwater pipeline installed.

D. One (1) compaction test shall be obtained for each 1 foot lift of native material along each 100 foot section of water, sewer or stormwater pipeline installed.

E. One (1) compaction test shall be obtained for each 1 vertical foot of native material placed around stormwater or sanitary sewer manholes.

F. A geotechnical testing representative shall be present at the time the sanitary sewer or stormwater pipeline and sanitary sewer or stormwater manholes are backfilled to monitor the placement of backfill material and complete compaction testing. Additional lifts shall not be installed until previous lifts have attained the specified compaction and is approved by the on-site geotechnical representative and Engineer.

3.07 CLEAN-UP

Immediately upon completion of Work for this Section, all rubbish and debris shall be removed from the Site. All pipe trench areas shall be finish graded with a "blade" or "motor patrol". All construction equipment and implements of service shall be removed and the entire area involved shall be left in a neat, clean and acceptable condition.

END OF SECTION

SECTION 02630 - DUCTILE IRON PIPE

PART 1 - GENERAL

1.01 DESCRIPTION

A. The Contractor shall furnish and install all ductile iron pipe, fittings, transitions, connections and appurtenant work, complete and in accordance with the requirements of the Contract Documents.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 02200 - Earthwork

B. Section 02221 - Trenching, Backfilling and Compacting

C. Section 02650 – Pipe Fittings

D. Section 02666 – Pressure Pipeline Water Testing

E. Section 02670 – Disinfection of Potable Water Pipelines

F. Section 09800 – Protective Coatings

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Commercial Standards:

ANSI/AWWA C 104/A 21.4	Cement-mortar lining for Ductile Iron and Gray Iron Pipe and Fittings for Water.
ANSI/AWWA C 105/A 21.5	Polyethylene Encasement for Gray and Ductile Cast Iron Piping for Water and Other Liquids.
ANSI/AWWA C 110/A 21.10	Fittings, 3-inch through 48-inch for Water and Other Liquids, Gray Iron and Ductile Iron.
ANSI/AWWA C 111/A 21.11	Rubber Gasket Joints for Ductile Iron and Gray Iron Pressure Pipe and Fittings
ANSI/AWWA C 115/A 21.15	Flanged Ductile Iron and Gray Iron Pipe with Threaded Flanges.
ANSI/AWWA C 150/A 21.50	Thickness Design of Ductile Iron Pipe.
ANSI/AWWA C 151/A 21.51	Ductile Iron Pipe, Centrifugally Cast, in Metal Molds or Sand-Lined Molds for Water and Other Liquids.
ANSI/AWWA C 209	Cold Applied Coatings for the Exterior of Special Sections, Connections and Fittings for Steel Water Pipelines.

ANSI/AWWA C 214	Tape Coating Systems for the Exterior of Steel Water Pipelines.
ANSI/AWWA C 600	Water Mains and Appurtenances, Installation of Ductile Iron.
ANSI/ASTM D 1248	Polyethylene Lining Material for Ductile Iron Pipe and Fittings.
ASTM C 150	Specification for Portland Cement.
ASTM A 746	Installation of Ductile Iron Pipe for Gravity Sewers.

1.04 CONTRACTOR SUBMITTALS

A. The Contractor shall furnish a certified affidavit of compliance for all pipe and other products or materials furnished under this Section of the Specifications and as specified in the referenced standards. Certification shall include physical and chemical properties of pipe materials and hydrostatic test reports.

B. All expenses incurred in sampling and testing for certifications shall be borne by the Contractor.

1.05 QUALITY ASSURANCE

A. Ductile iron pipe shall be manufactured with the material, have the dimensions, be within the tolerances and meet the testing requirements set forth in ASTM A 746 and ANSI A 21.51. Ductile iron pipe shall be manufactured in nominal 18 foot or 20 foot laying lengths and shall have the lining called for in the Contract Documents.

B. All pipe shall be subject to inspection at the place of manufacture in accordance with the provisions of the referenced standards, as supplemented by the requirements herein.

C. In addition to those tests specifically required, the Owner's Representative may request additional samples of any material including lining and coating samples for testing by the Owner. The additional samples shall be furnished at no additional cost to the Owner.

PART 2 - PRODUCTS

2.01 GENERAL

A. Mortar lined and polyethylene encased ductile iron pipe shall conform to ANSI/AWWA C 151, C 104, C 105, C 214 and D 1248, subject to the following supplemental requirements. The pipe shall be of the diameter and class shown, shall be furnished complete with rubber gaskets as indicated in the Contract Documents and all specials and fittings shall be provided as required under the Contract Documents. Any ductile iron pipes used as air lines and connected after the blowers shall have EPDM gaskets.

B. The pipe shall be handled by use of wide slings, padded cradles or other devices acceptable to the Owner's Representative, designed and constructed to prevent damage to the pipe lining and/or coating. The use of chains, hooks or other equipment which might injure the pipe lining and coating will not be permitted. Stockpiled pipe shall be safely and properly supported to prevent accidental rolling. The Contractor shall be fully liable for the cost of replacement or repair of pipe which is damaged.

C. Maximum pipe laying lengths shall be 20 foot with shorter lengths provided as required by the Design.

D. The pipe shall have a smooth dense interior surface and shall be free from fractures, defects and roughness.

2.02 MATERIALS

A. Ductile iron pipe materials shall conform to the requirements of ANSI/AWWA C 151/A 21.51.

B. Fittings for ductile iron pipe shall conform to the requirements of ANSI/AWWA C 110/A 21.10 for diameters 3 inch through 48 inch. Ductile iron fittings larger than 48 inch shall conform to the above-referenced standard with the necessary modifications for the larger size.

C. Cement for mortar lining shall conform to the requirements of ANSI/AWWA C 104/A 21.4; provided, that cement for mortar lining shall be Type V. A fly ash or pozzolan shall not be used as a cement replacement.

D. Material for the polyethylene encasement shall conform to the requirements of ANSI/AWWA C 105/A 21.5.

E. All elastomer gaskets used for ductile iron pipe shall be of neoprene material.

F. All buried bolts and nuts used in the assembly of ductile iron pipe and fittings shall be 316 stainless steel bolts.

2.03 DESIGN OF PIPE

A. Ductile iron pipe shall be designed in accordance with the requirements of ANSI/AWWA C 150/A 21.50, as applicable and as modified in this Section. The pipe furnished shall be cement-mortar lined. Buried ductile iron pipe shall be polyethylene encased.

B. The pipe shall be designed, manufactured, tested, inspected and marked according to applicable requirements previously stated and except as hereinafter modified, shall conform to ANSI/AWWA C 151.

C. The pipe and fittings shall be of the diameter shown and shall be of pressure Class 350 for pipe sizes twelve inches and below and pressure Class 250 for pipe fourteen inches to twenty inches and pressure Class 200 for twenty-four inch pipe and pressure Class 150 for thirty inch and above, except that where mechanical couplings are used and the pipe is grooved, the ductile iron pipe shall be of special thickness Class 53.

D. Ductile iron pipe and fittings shall be furnished with mechanical joints, push-on joints, flanged joints and restrained joints as required.

1. Mechanical and push-on joints shall conform to ANSI/AWWA C 111/A 21.11.

2. Flanged joints shall conform to ANSI/AWWA C 115/A 21.15.

3. Restrained joints shall be “Lok-Ring” Restrained Joint by American Ductile Iron Pipe, “TR FLEX” Restrained Joint by U.S. Pipe, “Mechanical/Lock Joint” by Pacific States Cast Iron Pipe Company, or equal.

E. For bell-and-spigot ends with rubber gaskets, the clearance between the bells and spigots shall be such that when combined with the gasket groove configuration and the gasket itself will provide watertight joints under all operating conditions when properly installed. The Contractor shall require the pipe manufacturer to submit details complete with significant dimensions and tolerances and also to submit performance data indicating that the proposed joint has performed satisfactorily under similar conditions. In the absence of a history of field performance, the results of a test program shall be submitted.

2.04 CEMENT-MORTAR LINING

A. Except as otherwise provided herein, interior surfaces of ductile iron pipe, fittings and specials to be furnished with cement-mortar lining shall be cleaned and lined in the shop with cement-mortar lining applied centrifugally in conformity with ANSI/AWWA C 104. If lining is damaged or found faulty at delivery site, the damaged or unsatisfactory portions shall be replaced with lining conforming to these Specifications.

B. The minimum lining thickness shall be as follows:

Nominal Pipe Diameter (inches)	Minimum Lining Thickness (inches)
3-12	1/8
14-24	3/16
30-54	1/4

C. For all pipe and fittings with plant-applied cement-mortar linings, the Contractor shall provide a polyethylene or other suitable bulkhead on the ends of the pipe and on all special openings. All bulkheads shall be substantial enough to remain intact during shipping and storage until the pipe is installed.

2.06 EXTERIOR COATING OF PIPE

A. The exterior surfaces of ductile iron pipe which will be exposed to the atmosphere inside structures or above ground shall be thoroughly cleaned and then given a shop coat of rust-inhibitive primer conforming to the requirements of Division 9. This exposed piping shall not be coated with the bituminous coating by the manufacturer prior to delivery.

B. Buried ductile iron pipe shall be polyethylene encased in accordance with the requirements of ANSI/AWWA C 105/A 21.5.

PART 3 - EXECUTION

3.01 INSTALLATION OF PIPE

A. All pipe, fittings, etc. shall be carefully handled and protected against damage, impact shocks and free fall. All pipe handling equipment shall be acceptable to the Owner's Representative. Pipe shall not be placed directly on rough ground, but shall be supported in a manner which will protect the pipe against damage whenever stored at the trench site in accordance with Paragraph 2.01, herein. All pipe damaged prior to Substantial Completion shall be repaired or replaced by the Contractor.

B. The Contractor shall inspect each pipe and fitting prior to installation to ensure that there are no damaged portions of the pipe. No pipe shall be installed where the lining or coating exhibit defects that may be harmful as determined by the Owner's

Representative. Such damaged lining or coating shall be repaired, or a new undamaged pipe shall be furnished and installed.

C. The pipe shall be installed in accordance with ANSI/AWWA C 600. Before placement of the pipe in the trench, each pipe or fitting shall be thoroughly cleaned of any foreign substance which may have collected thereon and shall be kept clean at all times thereafter. For this purpose, the openings of all pipes and fittings in the trench shall be closed during any interruption to the Work. As pipe laying progresses, the Contractor shall keep the pipe interior free of all debris. The Contractor shall completely clean the interior of the pipe of all sand, dirt, rocks and any other debris following completion of pipe laying prior to testing and disinfecting the completed pipeline.

D. Pipe shall be laid directly on the imported bedding material. No blocking will be permitted and the bedding shall be such that it forms a continuous, solid bearing for the full length of the pipe. Excavations shall be made as needed to facilitate removal of handling devices after the pipe is laid. Bell holes shall be formed at the ends of the pipe to prevent joint loading at the bells or couplings. Excavation shall be made as needed outside the normal trench section at field joints to permit adequate access to the joints for field connection operations and for application of coating on field joints.

E. Where necessary to raise or lower the pipe due to unforeseen obstructions or other cause, the Owner's Representative may change the alignment and/or the grades. Such change shall be made by the deflection of joints, by the use of bevel adapters or by the use of additional fittings. However, in no case shall the deflection in the joint exceed the maximum deflection recommended by the pipe manufacturer.

F. No pipe shall be installed upon a foundation into which frost has penetrated or at any time that there is a danger of the formation of ice or penetration of frost at the bottom of the excavation. No pipe shall be laid unless it can be established that the trench will be backfilled before the formation of ice and frost occurs.

G. The openings of all pipe and specials where the pipe and specials have been cement-mortar lined in the shop shall be protected with suitable bulkheads to prevent unauthorized access by persons, animals, water or any undesirable substance. At all times, means shall be provided to prevent the pipe from floating.

H. Immediately before jointing pipe, the bell end of the pipe shall be thoroughly cleaned and a clean rubber gasket lubricated with an approved vegetable-based lubricant shall be placed in the bell groove. The spigot end of the pipe shall be carefully cleaned and lubricated with a vegetable-based lubricant. The spigot end of the pipe section shall then be inserted into the bell of previously laid joint and telescoped into its proper position. Tilting of the pipe to insert the spigot into the bell will not be permitted.

END OF SECTION 02630

SECTION 02640 - PVC PIPE

PART 1 - GENERAL

1.01 DESCRIPTION

A. The Contractor shall furnish and install all Polyvinyl Chloride (PVC) plastic pipe, fittings, transitions, connections and appurtenant work, complete and in accordance with the requirements of the Contract Documents.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 02150 – Sheeting, Shoring and Bracing

B. Section 02200 - Earthwork

C. Section 02221 - Trenching, Backfilling and Compacting

D. Section 02666 – Pressure Pipeline Water Testing

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Commercial Standards:

ASTM D 1784 and ASTM D 1785	Specifications for Polyvinyl Chloride (PVC) Plastic Pressure Pipe
ASTM D 3034	Specifications for Polyvinyl Chloride (PVC) Plastic Gravity Sewer Pipe
AWWA C 900	Specifications for Polyvinyl Chloride (PVC) Plastic Water Pressure Pipe
ASTM D 2321	Standard Practice for Underground Installation of Flexible Thermoplastic Sewer Pipe
NSF / ASNI 61	Drinking Water System Components – Health Effects

1.04 CONTRACTOR SUBMITTALS

A. Contractor shall submit copies of the manufacturer's product specifications according to the requirements of Section 01300 - Contractor Submittals.

PART 2 - PRODUCTS

2.01 PVC (POLYVINYL CHLORIDE) PRESSURE PIPE, 4 INCHES AND SMALLER SOLVENT-WELDED

A. All PVC pressure pipe 4 inches and smaller shall be made from all new rigid unplasticized polyvinyl chloride and shall be Normal Impact Class 12454-B, Schedule 80, to conform to ASTM D 1785, unless otherwise shown. Elbows, tees, and fittings shall be of the same material and schedule as the pipe. Unless otherwise shown, joint design shall be for solvent-welded construction.

2.02 AWWA C 900 WATER PIPELINE WITH BELL AND SPIGOT JOINTS

This Specification designates general requirements for unplasticized polyvinyl chloride (PVC) plastic class water pipe with integral bell and spigot joints for the conveyance of water. Pipe shall meet the requirements of AWWA C 900 "Polyvinyl Chloride (PVC) Water Distribution".

All pipe shall be suitable for use as pressure conduit, provisions must be made for expansion and contraction at each joint with an elastomeric ring. The bell shall consist of an integral wall section with a factory installed, solid cross-section elastomeric ring which meets the requirements of ASTM F 477. The bell section shall be designed to be at least as hydrostatically strong as the pipe wall and meet the requirements of AWWA C 900. Sizes and dimensions shall be as shown in this Specification. Joint design shall meet qualification requirements of ASTM F 3139. Each pipe shall be tested to four times the pressure class of the pipe for a maximum of 5 seconds. The integral bell shall be tested with the pipe. Standard laying lengths shall be 20 feet (±1") for all sizes.

The pipe stiffness using F/ΔY for PVC class water pipe is contained in the table below:

CLASS	DR	FΔy (PSI)
100	25	129
150	18	364
200	14	815

Pipe shall withstand, without failure at 73°F, an impact of a falling missile, TUP C, at the following levels (per ASTM D 2444):

Pipe Size (IN.)	Impact (FT./LBS.)
4	100
6	100
8	100
10	120
12	120

There shall be no visible evidence of shattering or splitting when the energy is imposed.

Randomly selected samples tested in accordance with ASTM D 1599 shall withstand, without failure, pressures listed below when applied in 60-70 seconds.

Class	Minimum Burst Pressure At 73°F (PSI)
100	535
150	755
200	985

Pipe for this Project shall conform with the specifications for AWWA C 900, DR 18 PVC pipe material for diameter sizes 4-inches through 60 inches, unless otherwise indicated on the Plans.

2.03 PVC (POLYVINYL CHLORIDE) GRAVITY PIPE

A. Pipe shall conform to the requirements of ASTM D 3034 for SDR 35 gravity pipe, unless otherwise indicated on the Plans.

B. All pipe joints shall be of the bell and spigot type with electrometric seals and conform to the requirements of ASTM D 3212. Gaskets shall be factory installed and chemically bonded to the bell end of the pipe. Gasket material shall conform to the requirements of ASTM F 477.

C. All fittings shall be fabricated from pipe meeting the requirements of these standards. Fabricated miter joints shall be reinforced by fusion heat welding. All fittings shall be approved for use by the pipe manufacturer and shall be capable of accepting bell and spigot connections.

1. There shall be no sign of flaking or disintegration when immersed in anhydrous acetone for 20 minutes as described in ASTM D 2152.

D. All pipe shall be from quality PVC resin, compounded to provide physical and mechanical properties that equal or exceed cell class 12454 as defined in ASTM 1784.

E. Minimum pipe stiffness at 5 percent deflection shall be 46 PSI for all sizes when tested in accordance with ASTM D 2412, External Loading Properties of Plastic Pipe by Parallel-Plate Loading".

F. Each pipe shall be identified with the name of manufacturer, nominal size, cell classification, ASTM designation F 1803, the pipe stiffness designation "PS-46" and manufacturer's date code.

2.04 NSF / ANSI STANDARD 61

Piping, fittings, and appurtenances in contact with potable water or water that will be treated to become potable shall be listed in NSF / ANSI Standard 61 as being suitable for contact with potable water.

PART 3 - EXECUTION

3.01 INSTALLATION OF PIPE

A. All pipe, fittings, etc., shall be carefully handling and protected against damage, impact shocks and free fall. All pipe handling equipment shall be acceptable to the Engineer. Pipe shall not be placed directly on rough ground, but shall be supported in a manner which will protect the pipe against injury whenever stored at the Site. All pipe damaged prior to Substantial Completion shall be repaired or replaced by the Contractor.

B. The Contractor shall inspect each pipe and fitting prior to installation to ensure that there are no damaged portions of the pipe. Damaged pipe shall be replaced with new undamaged sections of pipe.

C. Before placement of the pipe in the trench, each pipe or fitting shall be thoroughly cleaned of any foreign substance which may have collected thereon and shall be kept clean at all times thereafter. For this purpose, the openings of all pipes and fittings in the trench shall be closed during any interruption to the Work. As pipe laying progresses, the Contractor shall keep the pipe interior free of all debris. The Contractor shall completely clean the interior of the pipe of all sand, dirt, rocks and any other debris following completion of pipe laying prior to testing, disinfecting and placing the completed pipeline in service.

D. Pipe shall be laid directly on the imported bedding material. No blocking will be permitted and the bedding shall be such that it forms a continuous, solid bearing for the

full length of the pipe. Bell holes shall be formed at the ends of the pipe to prevent joint loading at the bells or couplings.

E. Where necessary to raise or lower the pipe grade due to unforeseen obstructions or other causes, the Engineer may change the alignment and/or the grades. Such change shall be made by the deflection of joints or by the use of additional fittings. However, in no case shall the deflection in the joint exceed the maximum deflection recommended by the pipe manufacturer.

F. No pipe shall be installed upon a foundation into which frost has penetrated or any time that there is a danger of the formation of ice or penetration of frost at the bottom of the excavation. No pipe shall be laid unless it can be established that the trench will be backfilled before the formation of ice and frost occurs.

G. Immediately before jointing bell and spigot pipe, both the bell and spigot end of the pipe shall be thoroughly cleaned and lubricated with an approved vegetable-based lubricant. The spigot end of the pipe section shall then be inserted into the bell of the previously laid joint and telescoped into its proper alignment. Tilting of the pipe to insert the spigot into the bell will not be permitted.

H. Solvent-welded and heat-fused joints shall be carefully and thoroughly cleaned immediately before jointing the pipe. Particular care shall be taken in making solvent-welded joints to ensure a uniform, homogeneous and complete bond.

I. Pipe installation shall conform with Technical Specification Section 02221 - Trenching, Backfilling and Compacting. If this installation of pipe section and Section 02221 conflict, the most stringent specification shall apply.

END OF SECTION

SECTION 02650 –
PIPE FITTINGS, TRANSITION COUPLINGS, AND HARDWARE

PART 1 - GENERAL

1.01 DESCRIPTION

The Contractor shall provide and install pipe fittings, transition couplings, and hardware for the connection of PVC, ductile iron and other pipeline material. Other connecting items may also be required. This section includes the specifications and requirements for the prior listed pipe connection items. The hardware for this specification section shall include the hardware for pipe or any other fittings or items located along a pipeline. Material shall be new and free from defects.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 02630 - Ductile Iron Pipe

B. Section 02640 - PVC Pipe

1.03 REFERENCE DOCUMENTS

Unless otherwise indicated, the current editions of the following reference standards and specifications apply to the Work described herein, and are considered part of this Specification.

C 104/A 21.4-03	American National Standard for Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water
C 105/A 21.5-99	American National Standard for Polyethylene Encasement for Ductile-Iron Pipe Systems
C 110/A 21.10-03	American National Standard for Ductile-Iron and Gray-Iron Fittings, 3-In. through 48-In. (76 mm through 1,219 mm), for Water
C 111/A 21.11-00	American National Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
C 115/A 21.15-99	American National Standard for Flanged Ductile Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges
C 116/A 21.16-03	American National Standard for Protective Fusion-Bonded Epoxy Coatings for the Interior and Exterior Surfaces of Ductile-Iron and Gray-Iron Fittings for Water Supply Service
C 153/A 21.53-00	American National Standard for Ductile-Iron Compact Fittings, 3-In. (76 mm) through 64-In. (1,600 mm), for Water Service
ASTM A 536	American Standards for Testing and Materials - High Strength Ductile Iron for Sleeve and Flanges of Transition Coupling and Flanged Coupling Adapter
ASTM A 536-80, Grade 65-45-12	American Standard Testing and Material - Ductile Iron Mechanical Joint Restraint Fitting

UNI-B-13-92	As listed Underwriters Laboratories - Restraining Glands for Mechanical Restrained Joint Fittings
ASTM B 117	American Standard Testing Materials - Salt Spray Testing for Bolts

1.04 CONTRACTOR SUBMITTALS

A. The Contractor shall furnish a certified affidavit of compliance for all pipe and other products or materials furnished under this Section of the Specifications and as specified in the referenced standards. Certification shall include physical and chemical properties of pipe materials and hydrostatic test reports.

B. All expenses incurred in sampling and testing for certifications shall be borne by the Contractor.

1.05 QUALITY ASSURANCE

A. Ductile iron fittings shall be manufactured with the material, have the dimensions, be within the tolerances and meet the testing requirements set forth in ANSI A 21.53-00 and ANSI A 21.10-03.

B. All fittings shall be subject to inspection at the place of manufacture in accordance with the provisions of the referenced standards, as supplemented by the requirements herein.

C. In addition to those tests specifically required, the Owner's Representative may request additional samples of any material including lining and coating samples for testing by the Owner. The additional samples shall be furnished at no additional cost to the Owner.

PART 2 - PRODUCTS

The Technical Requirements for Ductile Iron Fittings, Transition Couplings, and Hardware follow:

2.01 DUCTILE IRON FITTINGS

Fittings and reducers for the water mains shall be composed of ductile iron. The ductile iron fittings shall conform to ASTM A 536. Mechanical joint fittings shall conform with AWWA C 153 C 350 PSI. Flanged fittings shall conform with AWWA C 110 C 250 PSI. Flange fittings shall have standard wall thickness not compact thickness. The fittings shall be cement-mortar lined in accordance with ANSI/AWWA C 104/A 21.4, Standard for Cement-Mortar Lining for Ductile Iron and Gray Iron Pipe Fittings for Water, latest revision. Asphaltic seal coating shall be applied to the interior and exterior of the below-grade fittings in accordance with ANSI/AWWA C 104/A 21.4, asphaltic seal coating shall be applied to the interior of the above-grade fittings. The exterior surfaces of above-grade ductile iron fittings shall be thoroughly cleaned and then given a shop coat of rust inhibitive primer conforming to the requirements of Division 9. This exposed piping shall not be coated with the bituminous coating by the manufacturer prior to delivery.

2.02 TRANSITION COUPLING

The transition couplings shall be installed as required. The center rings shall be constructed of ductile iron conforming to ASTM A 536-80, Grade 65-45-12. the end rings shall be constructed of ductile iron conforming to ASTM A 536, Grade 65-45-12. Gaskets shall be composed of virgin styrene butadiene rubber (SBR) compounded for water and sewer service in accordance with ASTM D 2000 MBA 810. The coating for the ductile iron transition coupling shall be fusion

bonded epoxy. The transition coupling shall be capable of sustaining a working pressure of 250 PSI.

2.03 RESTRAINED JOINT FITTINGS

Mechanical joint restraint shall be incorporated into the design for the follower gland. The gripping or restraining mechanism shall transmit uniform restraining pressure around the circumference of the pipe, thus avoiding point loading or pipe distortion. This restraining process shall be kept separate from the mechanical joint sealing process and ***not*** a part of the sealing function. All components shall be manufactured of ductile iron conforming to ASTM A 536-80, Grade 65-45-12.

The restrained twist-off nut bolt system shall have a torque limiting feature designed to break off at 75 to 90 FT-LBS of torque to insure proper actuating of restraining devices. Both the twist-off nut and the removal nut shall be the same size as tee-bolt nut. Hardware shall be composed of 316 stainless steel.

The gland shall be such that it can replace the standardized mechanical joint gland and can be used with the standardized mechanical joint bell conforming to ANSI/AWWA C 111/A 21.11, C 110/A 21.10 and C 153/A 21.53 of the latest revision.

The device shall restrain all classes of ductile iron, C 900 PVC, C 905 PVC and high-density polyethylene (HDPE) with the use of a standard mechanical joint gasket. The same device without any field modification shall additionally restrain IPS PVC, IPS steel and IPS HDPE with the use of a transition gasket.

The restraining glands shall have a pressure rating equal to twice (2:1) that of the pipe on which it is used. The restraining glands shall have been tested to UNI-B-13-92, be listed by Underwriters Laboratories and be approved by factory mutual. The mechanical joint restraint device shall be UNI-Bell, EBBA Series 2000, Sigma One-Lock or equal.

Restrained joint fittings shall be placed at all termination points, tees, bends, and angle points. Restrained joint fittings shall be placed for connection points of existing to new pipelines, unless noted in the plans. New pipeline-to-pipeline connections shall not be required to have restrained harness assemblies unless noted in the Plans.

2.04 HARDWARE

Hardware for ductile iron fittings shall conform with ANSI/AWWA C 111/A 21.11-07, Appendix “C”, Section C.1 entitled “Bolts and Nuts”. The size, length and number of bolts are illustrated in Tables 2 and 3 of ANSI/AWWA C 115/A 21.15.

Hardware for transition couplings and mechanical restrained joint fittings shall comply with the manufacturer’s recommendation for steel or ductile iron bolts and nuts.

For above ground and underground, all steel or ductile iron nuts and bolts shall be coated with a flouropolymer using Xylan/014 as a primary coating. The coating shall be electrostatically applied to the hardware after all surfaces are chemically cleaned, abrasive blasted and primed with a nickel phosphate primer. Multiple coats of the Xylan/014 shall be applied to the steel or ductile iron hardware and baked at 425°F for one (1) hour. Hardware protected with this coating system shall exhibit no signs of corrosion after salt spray testing up to 3,000 hours. The coating system shall be a Tripac 2000 Blue or an approved equal.

316 stainless steel hardware shall be used if specified for a given pipe, valve, fitting or other component on the Plans or within the contents of this document.

2.05 POLYETHYLENE ENCASEMENT

All ductile iron or gray iron fittings, transition couplings and coupling adapters shall be polyethylene encased at the time of installation. Polyethylene encasement and installation shall be in accordance with ANSI/AWWA C 105.

PART 3 - EXECUTION

3.01 INSTALLATION OF FITTINGS, TRANSITION COUPLINGS, AND HARDWARE

A. All fittings, etc. shall be carefully handled and protected against damage, impact shocks and free fall. All fittings, etc. handling equipment shall be acceptable to the Owner's Representative. Fittings, etc. shall not be placed directly on rough ground, but shall be supported in a manner which will protect the fittings, etc. against damage whenever stored at the trench site. All fittings, etc. damaged prior to Substantial Completion shall be repaired or replaced by the Contractor.

B. If during the course of fastening and securing the hardware (nuts and bolts) for the fittings, etc., the flouropolymer coated is scratched, chipped or otherwise removed from the hardware surface, then a coating system supplied by the manufacturer shall be applied to the damaged hardware surface. The repair coating system shall be applied prior to the backfilling or covering of the fittings, etc. hardware.

END OF SECTION 02650

SECTION 02666 – PRESSURE PIPELINE WATER TESTING

PART 1 - GENERAL

1.01 DESCRIPTION

A. The Contractor shall perform flushing and testing of all pipelines and appurtenant piping complete, including conveyance of test water from Engineer-designated source to point of use and disposal thereof after testing, in accordance with the requirements of the Contract Documents. The disposal method of the water shall be reviewed and approved by the Owner's Representative prior to the commencement of the test.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 02221 - Trenching, Backfilling and Compaction

B. Section 02630 - Ductile Iron Pipeline

C. Section 02640 - PVC Pipe

PART 2 – PRODUCTS

2.01 MATERIAL REQUIREMENTS

A. All test equipment, fuel, electrical connections, temporary valves, bulkheads, compressors, water pumps, water gauges and other water control equipment support systems and required materials for hydrostatic or pneumatic air testing shall be furnished by the Contractor subject to the Owner's Representative's review.

PART 3 – EXECUTION

3.01 GENERAL

A. The Contractor shall notify the Owner's Representative at least four (4) days in advance of any planned testing and shall review the testing procedures with the Owner's Representative. The source of testing water and disposal of the testing water shall be reviewed.

B. Unless otherwise provided herein, water for testing pipelines shall be furnished by the Owner; however, the Contractor shall make all necessary provisions for conveying the water from the Owner-designated source to the points of use. The Contractor shall provide inlet hoses, fittings, pressure gauges pumping equipment, meters, backflow preventers and other required items.

C. The Contractor shall provide a double bronze service saddle, brass corporation stop, inlet pipeline and outlet pipeline at the beginning and end of the pipeline section to be tested to allow water to be directed into the pipeline and air to be purged from the pipeline while the pipeline is filling with water. The fittings and pipe shall be used during the chlorination and disinfection of the pipeline. After the hydrostatic pipe testing and disinfection of the pipeline are satisfactorily completed remove the corporation stop from the brass service saddle. Place a brass plug in the service saddle inlet.

D. All pipelines shall be tested. All testing operations shall be performed in the presence of the Owner's Representative.

E. The disposal or release of test water from pipelines, after testing, shall be acceptable to the Owner's Representative. The conveyance items to dispose of the testing water shall be provided by the Contractor.

3.02 HYDROSTATIC TESTING OF PIPELINES

A. Prior to hyrdrostatic testing, all pipelines shall be thoroughly flushed of all sand, dirt and material to the satisfaction of the Owner's Representative. The Contractor shall test all pipelines either in sections or as a unit. The Contractor shall be responsible to insure all test bulkheads are suitably restrained to resist the thrust of the test pressure without damage to, or movement of, adjacent pipe or structures. Care shall be exercised to insure that all air vents are open during filling.

B. The pipeline shall be filled at a rate which will not result in surges or exceed the rate at which the air can be released through the air valves at a reasonable velocity and all the air within the pipeline shall be properly purged. After the pipeline or section thereof has been filled it shall be allowed to stand under a slight pressure for at least 24 hours to allow the concrete or mortar lining, if applicable, to absorb water and allow the escape of air from the pipeline. During this period, bulkheads, valves and connections shall be examined for leaks. If leaks are found, corrective measures shall be initiated and completed to the satisfaction of the Owner's Representative.

C. The hydrostatic test shall consist of holding the test pressure within the pipeline for a period of 4 hours. The test pressure for pipelines shall be 150 PSI or 1.5 times the rated pipe pressure class which ever is greater. All leaks shall be repaired. The hydrostatic pressure shall be relieved from the pipeline prior to initiating leak repair.

D. Pipe leaks, as evidenced by water loss from the basin from which water is pumped into the pipeline, shall not be allowed after the test begins. Test pressures shall be held for at least two (2) hours after the test commences without additional pumping and observed for not less than four (4) hours. Approved gauges shall be provided by the Contractor. Gauge range shall not exceed 50 PSI above test pressure. In the event leaks occur after the hydrostatic test commences, the Contractor shall determine the cause of the leakage and take corrective measures necessary to repair the leaks. After the leaks are satisfactorily repaired the pipeline shall be re-tested.

3.03 AIR TESTING OF WATER PIPELINE

In lieu of hydrostatic testing of water pipeline sections within the water treatment plant area, air testing shall be allowed.

A. The Contractor shall leak test 100% of the pipeline installed. The leak testing shall be accomplished after any required deflection testing of the pipeline is completed.

B. Pipelines shall be subject to acceptance testing after backfilling has been completed but prior to the placement of the finish surface material (i.e. Class 2 Base, A.C. pavement and P.C.C. concrete).

C. The cost of repairs or corrections necessary to conform to the testing requirements will be borne by the Contractor at no cost to the Owner.

D. Air testing will be accomplished by the means of "Low Pressure Air Testing". Tests may be conducted by the Contractor or an independent testing firm. However, acceptance tests shall be made only in the presence of the Owner's Representative.

E. Test Procedure:

1. Before testing, the pipe shall be thoroughly cleaned.

2. The Contractor shall seal off the section of pipe to be tested at each pipe beginning and termination point. Test plugs must be securely braced at the beginning and termination points of the pipeline.

3. A minimum of two (2) connection hoses to link the air inlet test plug with an aboveground test-monitoring panel must be provided.

   a) One (1) hose is to induce air through the test plug and into the test chamber.

   b) The second hose is for the purpose of monitoring the test pressure from within the enclosed pipe.

4. Under no circumstances are workers to be allowed in the area of the braced pipeline beginning and termination points while pressure testing is being conducted.

5. Add air slowly into the test section. After an internal pressure of 4.0 PSI is obtained, allow internal air temperature to stabilize for a minimum of 2 minutes.

6. After the stabilization period, adjust the internal air pressure to 3.5 PSI, disconnect the air supply and begin timing the test.

7. Refer to the following pipeline air test table to determine the length of time (minutes) the pipeline section being tested must sustain air pressure while not losing in excess of 1 PSI as monitored by the test gauge. If the section of pipeline to be tested includes more than one pipe size, calculate the test time for each size and add the test times to arrive at the total test time for the section.

8. Sections so determined to have lost 1 PSI or less during the test period will have passed the leakage test. Those sections losing in excess of 1 PSI during the test period will have failed the leakage test.

9. Appropriate repairs must then be conducted and re-test the pipe for acceptance.

PIPELINE AIR TEST TABLE

Minimum Test Time for Various Pipe Sizes*

Nominal Pipe Size, In.	T (Time), Min/100 FT.	Nominal Pipe Size, In.	T (Time), Min/100 FT.
3	0.2	21	3.0
4	0.3	24	3.6
6	0.7	27	4.2
8	1.2	30	4.8
10	1.5	33	5.4
12	1.8	36	6.0
15	2.1	39	6.6
18	2.4	42	7.3

*The time has been established using the formulas contained in ASTM C 828, Appendix

END OF SECTION

SECTION 02670 - DISINFECTION OF POTABLE WATER PIPELINES

PART 1 - GENERAL

1.01 DESCRIPTION

Potable pipelines within the water distribution system, Water Treatment Plant, and other areas are to be disinfected prior to being connected to other existing active pipelines and placed in service. The new pipelines are to be isolated from the existing active pipelines (usually by means of a closed valve) until the pipeline has been satisfactorily hydrostatically tested, leak tested (if required) and disinfected. The pipelines shall be hydrostatically, and leak tested as a separate procedure from the pipeline disinfection.

1.02 PURPOSE

The purpose of this standard is to define the minimum requirements for the disinfection of water mains, including the preparation of water mains, application of chlorine, and sampling and testing for the presence of coliform bacteria.

1.03 REFERENCE SECTIONS

Reference sections pertaining to the disinfection testing are as follows:

Section 02630	Ductile Iron Pipe
Section 02640	PVC Pipe
Section 02666	Pressure Pipeline Water Testing
ANSI/AWWA C 651-05	American National Standards Institute/ American Water Works Association
ANSI/AWWA B 300	Hypochlorites
ANSI/AWWA B 301	Liquid Chlorine
AWWA Manual M 12	*Simplified Procedures for Water Examination,* AWWA: Denver, Colorado

SECTION 2 - PRODUCTS

2.01 GENERAL

A. Construction of Pipeline, Associated Fittings, Valves and Components:

The Contractor shall train pipe crews to be aware of the need to maintain clean pipes, fittings, etc and avoid contamination. While bacteriological testing is used to verify the absence of coliform organisms and is generally accepted as verification that disinfection of the pipeline has been accomplished, following sanitary practices for handling and installation of pipe, valves, fittings, and accessories, coupled with adequate flushing of the line before disinfection, is necessary to ensure that the disinfected pipeline will be ready for connection to the water system. Failure to pass the bacteriological test shall require that the flushing or disinfection process be repeated. The final water quality test is not the primary means for certifying the sanitary condition of a main. The sanitary

handling of materials, the practices during construction, and the continual inspection of the work are the primary means for ensuring the sanitary condition of the water main.

B. Methods of Disinfecting Newly Constructed Water Pipelines and the Acceptable Method of Disinfecting Pipelines:

The three methods of disinfecting newly constructed water mains are the tablet method, the continuous-feed method and the slug method. Factors considered when selecting a method include the length and diameter of the main, type of joints present, availability of materials, equipment required for disinfection, training of the personnel who will perform the disinfection, and safety concerns. This Project shall allow chlorination of pipelines by the continuous feed method. The tablet method and slug method shall not be allowed.

The tablet method shall not be used unless the main can be kept clean and dry. It shall not be used in large-diameter mains if it is necessary for a worker to enter the main to grout joints or perform inspection, because the tablets may release toxic fumes after exposure to moist air. When using the tablet method, the chlorine concentration is not uniform throughout the main, because the hypochlorite solution is dense and tends to concentrate at the bottom of the pipe. The use of the tablet method precludes preliminary flushing. The tablet method is convenient to use in mains having diameters up to 24 inches, and it requires no special equipment.

The continuous-feed method is suitable for general application. Preliminary flushing removes light particulates from the main but not from the pipe-joint spaces. The chlorine concentration is uniform throughout the main.

The slug method is suitable for use in large-diameter mains where the volume of water makes the continuous-feed method impractical and difficult to achieve for short attachments. The slug method results in appreciable savings of chemicals used to disinfect long, large-diameter mains. Also, this method reduces the volume of heavily chlorinated water to be flushed to waste.

C. Forms of Chlorine for Disinfection:

The forms of chlorine that may be used in the disinfection operations are liquid chlorine, sodium hypochlorite solution, and calcium hypochlorite granules or tablets. For this Project, liquid chlorine shall be used unless otherwise approved by the Owner's Representative.

1. ***LIQUID CHLORINE***: Liquid chlorine conforming to ANSI/AWWA B301 contains 100 percent available chlorine and is packaged in steel containers usually of 100-lb., 150-lb., or 1-ton net chlorine weight. Liquid chlorine shall be used only (1) in combination with appropriate gas-flow chlorinators and ejectors to provide a controlled high-concentration solution feed to the water to be chlorinated; (2) under the direct supervision of personnel familiar with the biological, chemical and physical properties of liquid chlorine and who are trained and equipped to handle any emergency that may arise; and (3) when appropriate safety practices are observed to protect working personnel and the public.

2. ***SODIUM HYPOCHLORITE***: Sodium hypochlorite conforming to ANSI/AWWA B300 is available in liquid form in glass, rubber-lined, or plastic containers typically ranging in size from 1 quart to 5 gallons. Containers of 30 gallons or larger may be available in some areas. Sodium hypochlorite contains approximately 5 percent to 15 percent available chlorine, and the storage conditions and time must be controlled to minimize its deterioration. (Available

chlorine is expressed as a percent of weight when the concentration is 5 percent or less, and usually as a percent of volume for higher concentrations. Percent x 10 = grams of available chlorine per liter of hypochlorite.)

3. ***CALCIUM HYPOCHLORITE***: Calcium hypochlorite conforming to ANSI/AWWA B300 is available in granular form or in 5-g tablets, and must contain approximately 65 percent available chlorine by weight. The material should be stored in a cool, dry, and dark environment to minimize its deterioration.

   CAUTION: Tablets dissolve in approximately 7 hours and must be given adequate contact time. Do not use calcium hypochlorite intended for swimming pool disinfection, as this material has been sequestered and is extremely difficult to eliminate from the pipe after the desired contact time has been achieved.

D. Preventative and Corrective Measures to be Implemented during the Construction of Pipelines:

Heavy particulates (dirt, soil, rocks, etc.) generally contain bacteria and prevent even very high chlorine concentrations from contacting and killing organisms. Therefore, the procedures of this Section shall be stringently implemented by the Contractor and enforced by the Owner's Representative to ensure that water pipelines, fittings, etc., have been thoroughly cleaned before flushing the pipeline for the final disinfection by chlorination. Also, any connection of a new water main to the active distribution system prior to the receipt of satisfactory bacteriological samples constitute a cross-connection in violation of the California Health Department requirements. The new main shall be isolated until bacteriological tests described later in this Section are satisfactorily completed. The Contractor shall complete the following tasks or observe the following precautionary measures during the installation of the water pipeline:

1. The interiors of pipes, fittings and valves shall be protected from contamination by dirt, debris, rocks, concrete residue, water and similar items.

2. Openings in the pipeline shall be closed with watertight plugs when pipe laying is stopped at the close of the day's work or for other reasons, such as rest breaks or meal periods. Rodent-proof plugs may be used when watertight plugs are not practicable and when thorough cleaning will be performed by flushing or other means.

3. Delay in placement of delivered pipe invites contamination. Pipe delivered to the site shall be covered with tarps. The tarps shall be placed over the pipes and end of the pipes to minimize the entrance of dirt, dust and construction debris.

4. Sealing Materials: No contaminated material or any material capable of supporting growth of microorganisms shall be used for sealing joints. Sealing material or gaskets shall be handled in a manner that avoids contamination. The lubricant used in the installation of sealing gaskets shall be suitable for use in potable water and shall not contribute odors. It shall be delivered to the job in closed containers and shall be kept clean and applied with dedicated, clean applicator brushes.

5. If dirt or other contaminants enter a pipeline, fitting, transition coupling, valve or any other pipeline, it shall be swept from the interior of the pipeline, fitting, etc. The contaminated area shall be wiped clean with an ammonia solution disinfectant. After each pipe section is installed the end of the pipe shall be inspected for the entrance of dirt and other contaminants. If dirt or contaminants

are identified the dirt and contaminants shall be removed prior to the installation of the next pipe length. Correspondingly, the pipe end to be "stabbed" into the previously installed pipe segment shall be checked for dirt contamination and cleaned and disinfected accordingly.

6. Flooding by Storm or Accident during Construction: If the pipeline is flooded during construction, it shall be cleared of the floodwater by draining and flushing with potable water until the main is clean. The section exposed to the floodwater shall then be filled with a chlorinated potable water that, at the end of a 24-hour holding period, shall have a free chlorine residual of not less than 25 mg/L. The chlorinated water shall then be drained or flushed from the main. After construction is completed, the main shall be disinfected for a second time using the continuous-feed method.

PART 3 - EXECUTION

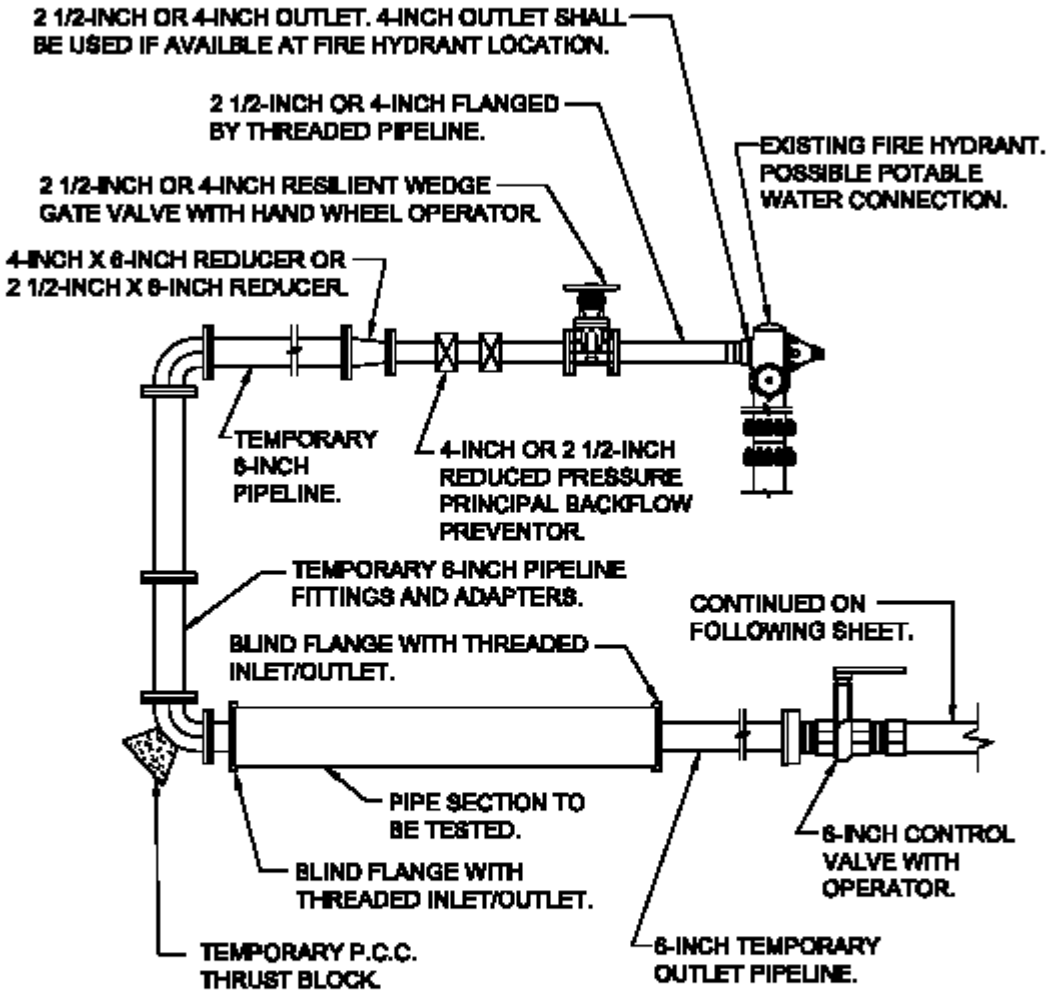
3.01 GENERAL

The water pipeline shall be thoroughly flushed with potable water prior to the chlorination of the pipeline. Prior to the flushing of the water pipeline it may be necessary to construct temporary flushing and testing connections at the upstream and downstream ends of the pipelines to be tested. If new pipelines are to be connected to existing in-service pipelines with new valves installed at the connection fittings between the new and existing pipelines which reliably isolate the new pipeline from the existing in-service pipeline, then blowoffs and properly positioned fire hydrants allow for the adequate flushing of the pipeline and allow for the dispersion of chlorine by the continuous-feed method. This method is particularly applicable to new commercial or residential developments which occur within an existing pipe distribution system.

If new pipelines are to be connected to existing in-service pipelines, concrete structures and reservoirs with no reliable valve at the connection point of the new pipeline to isolate the new pipeline from the existing in-service pipelines, concrete structures and reservoirs, then temporary caps or plugs (blind flanges), supply hoses, control valves, backflow devices, discharge/flushing lines and sampling faucets shall be constructed. This pipeline condition often occurs within water treatment plants. The pipelines within water treatment plants in the condition described within this paragraph shall be flushed, chlorinated and tested while physically separated from existing in-service pipelines, reservoirs and concrete structures. The physically separated pipeline section shall be hydrostatically tested prior to the flushing, chlorination and testing of the pipeline section. Potable water from an outside source shall be required to be conveyed to the new pipeline for flushing and disinfecting via a temporary connection supplied and installed by the Contractor. The temporary connection shall be disconnected (physically separated) from the new pipeline during the hydrostatic pressure test. The temporary connection shall include a reducer fitting from the fire hydrant, 4 inch control valve, 4 inch backflow preventer based upon a reduced pressure principal, 4 inch supply hose or pipeline, temporary testing block, blind flange with 4 inch threaded outlet, 4 inch discharge piping, 4 inch discharge control valve and smooth, unthreaded sampling faucet. It shall be necessary for the Contractor to provide all other necessary fittings, adapters, hardware and other components. The discharge pipeline shall extend to a discharge point acceptable to the Owner's Representative. If the discharge pipeline extends through on-site roadways or into the public right of way then the Contractor shall place the temporary discharge pipeline below grade. The Contractor shall perform all cutting, demolition and replacement of P.C.C. infrastructure as required by Division 1 of the Technical Specifications. The Contractor shall core the side of manholes, install the discharge pipeline to the interior wall face of the manhole and grout the annular space between the exterior circular core and the exterior of the pipeline for the full thickness of the manhole shaft with a non-shrink grout. At the conclusion of the pipeline disinfection all upstream and downstream pipelines, supply hoses, valves, check valves, fittings, blind flanges and components shall be removed from the Project Site. The interior

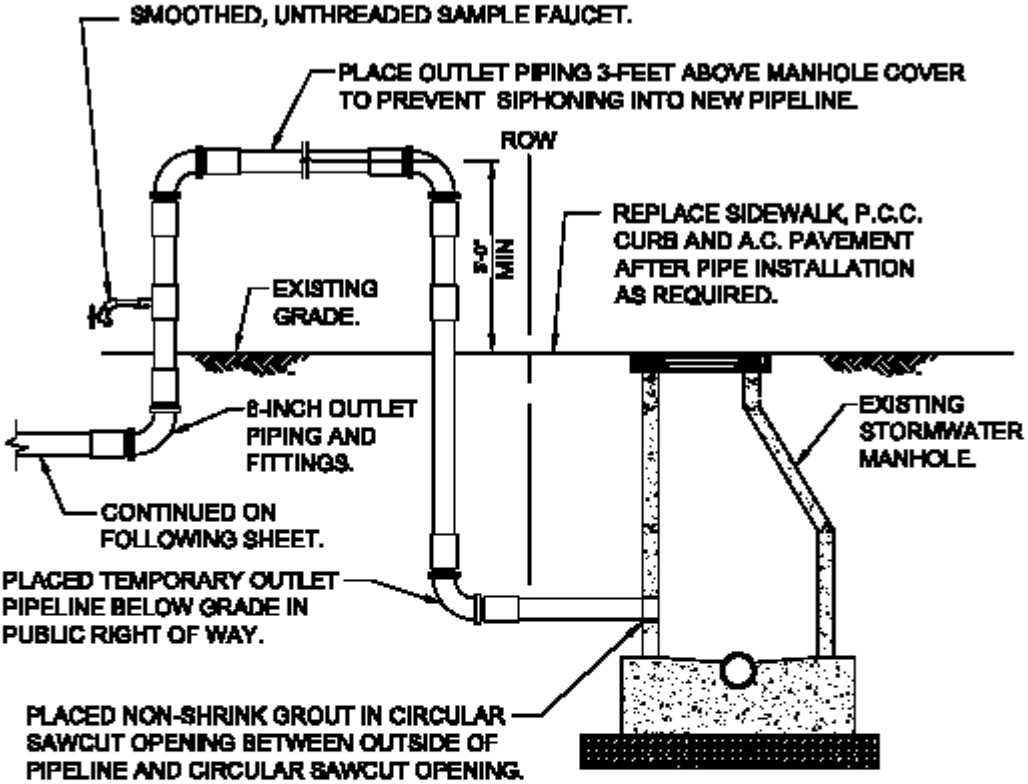
of any discharge pipeline extending into manholes shall be plugged for the full width of the manhole shaft wall width with a non-shrink grout.

A schematic of the temporary flushing/testing connection and schematic of the discharge blowoff/sampling tap pipeline follows. The schematic drawings are intended to illustrate the concept and major components required for the disinfection of the pipeline. The schematics do not illustrate each fitting, adapter and component required for the flushing/testing connection pipeline or the discharge blowoff/sampling tap pipeline nor do the schematics illustrate the lengths of pipelines required, number of fittings, number of valves, etc. The schematics do not illustrate where the source of water is to be obtained or the discharge point the blowoff pipeline is to extend to. It is the responsibility of the Contractor to determine the source of the potable water, length of the connection pipeline, exact number and type of fittings, valves and adapters, length of the blowoff pipeline, exact number and type of fittings, valves and adapters, paving and concrete demolition and replacement requirements and similar logistical placement, pipe mechanic and civil infrastructure issues. Following are the Temporary Flushing/Testing Connection Schematic and Blowoff Sampling Point Discharge Pipeline Schematic Drawings:



TEMPORARY FLUSHING/ TESTING AND BLOWOFF/ SAMPLING FITTINGS AND PIPING SCHEMATIC

SHEET 1 OF 2



TEMPORARY FLUSHING/ TESTING AND BLOWOFF/ SAMPLING FITTINGS AND PIPING SCHEMATIC

SHEET 2 OF 2

3.02 CHLORINATION PROCEDURE

A. Pipeline shall be thoroughly flushed prior to the commencement of the introduction of chlorine disinfectant.

Pipelines within a distribution system or a network of pipelines shall be flushed at each hydrant, blowoff, or service pipeline. It shall be necessary to install sampling/blowoff assemblies at the termination ends of pipe segments to allow the extremities of the pipeline to be flushed and for chlorinated water to be dispersed throughout the new water pipeline section in the event blowoffs or fire hydrants are not placed at the extremities of the pipeline to be tested. At least one (1) blowoff/sampling point assembly shall be placed at the extremities of the pipe section to be tested for sampling purposes. Sampling shall not be allowed through fire hydrants or water fittings with threaded ends. The Contractor shall install at least one (1) blowoff/sampling assembly at the end of each pipeline section to be tested; even if the blowoff/sampling assembly is not illustrated on the Plans. The Contractor shall be required to install the blowoff/sampling assembly as a requirement of this pipeline disinfection specification section. The Contractor shall not be compensated for the costs of the blowoff/sampling assembly. The cost of the installation of the blowoff/sampling assembly shall be incidental to the costs of disinfecting the pipeline.

Pipelines physically separated from existing in-service pipelines, reservoirs and concrete structures (as is often the case at Water Treatment Plants), shall be flushed with temporary pipeline connections upstream and downstream of the pipeline section to be disinfected as described in Section 3.01 of this specification.

Flushing of pipelines within a distribution system shall occur through fire hydrants, blowoffs, water services and blowoff/sampling points for a minimum of 10 minutes with the potable water source placed at maximum flow and maximum pressure. Flushing shall continue until no evidence of dirt is evident from the discharge water. Flushing shall be accomplished through fire hydrants or blowoffs if possible. Flushing of the water pipeline shall occur through a blowoff/sampling point assembly as a last resort. The pipeline contractor shall take necessary precautions to avoid damage to existing structures and utilities.

Flushing of physically separated pipelines shall be accomplished for a minimum of 10 minutes with the potable water source placed at maximum flow and maximum pressure. Flushing of the pipeline shall continue until no evidence of dirt is visible from the discharge water entering the downstream deposition point. The pipeline contractor shall take necessary precautions to avoid damage to existing structures and utilities.

B. After flushing of the water pipelines is satisfactorily accomplished and approved by the Owner's Representative, chlorinated water shall be introduced to the pipeline. The pipelines shall be chlorinated in accordance with AWWA C 651.

The continuous-feed method of chlorine application shall be employed. The use of chlorine tablets or granules shall not be allowed.

Direct-feed chlorinators, which operate solely from gas pressure in the chlorine cylinder, shall not be used for the application of liquid chlorine. (The danger of using direct-feed chlorinators is that water pressure in the main can exceed gas pressure in the chlorine cylinder. This allows a backflow of water into the cylinder, resulting in severe cylinder corrosion and the escape of chlorine gas.) The preferred equipment for applying liquid chlorine is a solution-feed, vacuum-operated chlorinator and a booster pump. The vacuum-operated chlorinator mixes the chlorine gas in solution water; the booster pump injects the chlorine-gas solution into the main to be disinfected. Hypochlorite solutions may be applied to the water main with a fuel or electrically powered chemical-feed pump designed for feeding chlorine solutions. Feed lines shall be made of material capable of

withstanding the corrosion caused by the concentrated chlorine solutions and the maximum pressures that may be created by the pumps. All connections shall be checked for tightness before the solution is applied to the pipeline.

Chlorine shall be dispersed through the pipeline at 100 ppm. Chlorine shall be flushed through all fire hydrants, blowoffs, water services and blowoff/sampling assemblies. Chlorine shall continue to be flushed through the above listed items until the chlorine concentration is measured at 100 ppm or greater.

The chlorinated water shall remain in the pipeline for a minimum 24-hour period and not longer than 48 hours. The chlorine residual shall be a minimum of 50 ppm after the 24 hour period; or prior to flushing the heavily chlorinated water from the pipeline. The heavily chlorinated water shall not remain in the pipeline over 48 hours as prolonged exposure to the heavily chlorinated water may damage (corrode) pipelines, fittings, valves and other piping components. The heavily chlorinated water shall be flushed from the pipeline, pipeline fittings, water services, fire hydrants, blowoffs, blowoff/sampling assemblies and all other pipe connections. The heavily chlorinated water shall be flushed until chlorine samples of the flushed water confirm that the chlorine concentration is no higher than the water in the in-service distribution system or the water source used for the disinfection process.

The environment to which the heavily chlorinated water is to be discharged shall be inspected. In the opinion of the Owner's Representative, if there is a possibility that the chlorinated water will result in damage to the environment, then the Owner's Representative shall require a neutralizing chemical be applied to the water to be wasted (prior to discharge) by means of a neutralizing chemical. Neutralizing chemicals may be sulfur dioxide, sodium bisulfite, sodium sulfite, sodium thiosulfate or ascorbic acid. Appendix "C" of ANSI/AWWA C 651-05 lists the neutralizing chemicals and the suggested neutralizing chemical concentrations per 100,000 gallons of water.

The Contractor shall be responsible for the discharging of the heavily chlorinated water. The Contractor shall provide all piping, fittings, etc. to convey the heavily chlorinated water from the disinfected pipeline per Item 3.01 of this Specification.

C. After final flushing and before the disinfected water pipeline is connected to the distribution system or in-service pipeline system, two (2) consecutive sets of acceptable samples, obtained a minimum of 24 hours apart, shall be collected from the disinfected pipeline.

One (1) set of samples shall be collected from every 1,200 feet of new water pipeline and one (1) set shall be obtained from the end point(s) of the disinfected water pipeline(s). If disinfected water pipelines terminate (dead-end) at cul-de-sacs, a sample shall be obtained from the termination point of the pipelines. As was noted by the previous sections, The Contractor shall install blowoff/sampling point assemblies at pipeline termination points as required.

Samples shall be tested for bacteriological (chemical and physical) quality in accordance with *Standard Methods for the Examination of Water and Wastewater* and shall show the absence of coliform organisms; and chlorine residual. Turbidity, pH, and a standard heterotrophic plate count (HPC) test shall be required. New pipeline does not typically contain coliforms but does typically contain HPC bacteria.

Samples for bacteriological analysis shall be collected in sterile bottles treated with sodium thiosulfate, as required by *Standard Methods for the Examination of Water and Wastewater*. No hose, fire hydrant or threaded fitting outlet shall be used in the collection of samples. There should be no water in the trench up to the connection for

sampling. The sampling pipe must be dedicated and clean and disinfected and flushed prior to sampling.

If sample results from the lab indicate a measured HPC greater than 500 colony-forming units (cfu) per ml, flushing should be resumed and another coliform and HPC set of samples shall be obtained until no coliforms are present and the HPC is less than 500 cfu/ml.

The record of disinfection compliance shall be the bacteriological test results certifying that the water sampled from the disinfected water main is free of coliform bacteria contamination and is equal to or better than the bacteriologic water quality in the distribution system.

If the initial disinfection fails to produce satisfactory bacteriological results or if other water quality is affected, the disinfected pipeline may be reflushed and shall be resampled. If succeeding samples also fail to produce acceptable results, the disinfected pipeline shall be rechlorinated by the continuous-feed method until satisfactory results are obtained, satisfactory results being derived from two (2) consecutive sets of acceptable samples taken 24 hours apart.

The Contractor shall be responsible for all expenses relative to the chlorination and disinfection of the pipelines. The costs of re-testing shall also be borne by the Contractor. The City or District Water Department within which the disinfected pipeline is located shall coordinate obtaining the tests and select the testing laboratory to perform the tests. The Contractor shall be responsible for all expenses relative to the laboratory testing.

The disinfected pipeline shall not be placed in service until evidence that the bacteriological tests have proved negative and successfully met the testing requirements and are presented to the Owner's Representative. The Owner's Representative shall allow the disinfected pipeline(s) to be connected to the in-service pipeline after the evidence is presented to him/her by the Contractor. The evidence shall consist of the original laboratory report document certifying the laboratory test results comply with the disinfection requirements of this document.

3.03 FINAL CONNECTION PIPE SEGMENT DISINFECTION REQUIREMENTS

If approved by the Owner's Representative, final connection pipe segments (measuring 18.5 feet or less) located between the existing in-service pipeline and the valve or temporary termination point of a successfully disinfected pipe section may be spray disinfected or swabbed with a minimum 1-5 percent solution of chlorine prior to final installation. The installation of the final connection pipe segment shall be witnessed by the Owner's Representative. If dirt, debris or any contaminating substances enter the pipe section between the disinfection process and installation process the pipe section shall be removed and re-disinfected. The Contractor shall immediately remove the pipe section from the pipe trench and re-disinfect the pipe section if required by the Owner's Representative. The disinfection of the pipeline shall require that all dirt, construction residue, dust and contaminants be thoroughly pressure washed from the interior of the pipeline, valve, fitting, transition coupling and other pipe component interior surfaces. The interior surfaces shall be dried clean with a cloth or paper towels. The interior surfaces shall then be disinfected with the minimum 1-5 percent solution of chlorine. The pipe section shall not be allowed to be set in place for connection to the existing in-service pipeline until the Owner's Representative approves the witnessed disinfection of the pipeline section.

END OF SECTION 02670

SECTION 02680 - TESTING OF HYDRAULIC STRUCTURES

PART 1 - GENERAL

1.01 DESCRIPTION

Test all concrete tanks, hydraulic channels, sumps, pump wet wells, basins and other structures designed to contain water, after concrete has reached the design strength, prior to back-filling and application of any coating system. Test by filling structure with water. The Contactor shall perform all cleaning, flushing, testing and appurtenant work, including conveyance of test water from Owner-designated source to point of use, and including all disposal thereof, complete and acceptable, for hydraulic structures and appurtenant piping all in accordance with the requirements of the Contract Documents.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 03300 - Cast-In-Place Concrete

B. Section 02666 - Pressure Pipeline Water Testing

B. Section 02726 – Manhole and Precast Vault Construction

PART 2 - PRODUCTS

2.01 MATERIALS REQUIREMENTS

A. Temporary hoses to convey water to the structures, temporary bulkheads, water plugs, electrical circuitry, pumps, fuel, suction hoses, discharge hoses and any other ancillary materials.

PART 3 - EXECUTION

3.01 GENERAL

A. Prior to testing, all hydraulic structures shall be thoroughly cleaned and all surfaces hosed down with a high-pressure hose and nozzle. All water, dirt and foreign material accumulated in this cleaning operation shall be removed from the structure and disposed of by the Contractor.

B. All hydraulic structures and appurtenant piping shall be tested for leaks. All testing operations shall be conducted in the presence of the Engineer.

C. The Contractor shall notify the Engineer at least four (4) days in advance of any planned testing and shall review the testing procedures with the Engineer. The source of water, conveyance of water and disposal of water shall be reviewed.

D. Water for testing will be furnished by the Owner; however, the Contractor shall make all necessary provisions for conveying the water from the Owner-designated source to the points of use. The Contractor shall be responsible for removing the water from the structure at the conclusion of the testing and locating an acceptable point of discharge approved by the Engineer.

E. If industrial paint finishes or other protective coatings are to be applied to the interior surfaces of the hydraulic structure, such coatings shall be applied after all testing operations have been completed.

F. All evaporation and level measuring devices required shall be provided by the Contractor.

G. All pumps, power, piping, fuel and any other equipment, fittings and accessories required to make all connections necessary to fill the structure with water prior to testing and emptying the structure of water after testing.

H. Contractor shall fill the structure with water to the extreme high operating water surface level or to overflow weir level. The fill level shall be determined by the Engineer.

I. Maintain full for 48 hours before beginning the test period to permit concrete absorption and adjustment of valves, slidegates or temporary bulkheads.

J. At completion of tests remove all temporary piping and connections. Dispose of testing water to a location acceptable to the Engineer.

3.02 TESTING PERIOD AND PROCEDURE

A. Test Period: Five (5) consecutive 24 hour periods totaling 5 days. Contractor shall obtain daily measurements of air and water temperature, rainfall and water level.

B. Test Procedure:

1, After test period, Contractor shall measure water level at each side of the tank to determine leakage and loss from evaporation. Engineer shall observe and verify measurements and evaporation loss.

2. Contractor shall determine evaporation loss, using a standard 48 inch evaporation pan and level measuring device located adjacent to the tank. Engineer shall observe the evaporation loss procedure.

3. Contractor shall mark all running or dripping leaks on exposed surfaces that have not healed autogenously during the test. Contractor shall repair all identified areas to the satisfaction of the Engineer.

4. If leakage from the structure exceeds 0.25% of the storage capacity of the concrete structure, then Contractor shall identify the location of the leaks and repair the leaks. Obtain measurements on a daily basis. If the water loss exceeds the 5 day allowable leakage after a daily reading, then leakage repair shall immediately commence.

5. Complete repair work in accordance with Division 3 - Concrete Specifications. Repairs by painting or surface treatment will not be acceptable.

6. Continue the test and repair leaks iteratively until the structure satisfies both the leakage calculation requirement and the visible leakage requirement.

3.03 CLEAN UP AND POST-TESTING ITEMS

A. Upon completion of all work performed under this Section, remove from the site all excess materials, storage facilities and temporary facilities. Smooth and remove off

debris from areas which were used or occupied during concrete construction and leakage testing.

B. Remove all testing water from the concrete structures. After clean-up items are satisfactorily accomplished, backfilling of the concrete structures and coating operations shall be allowed to proceed.

END OF SECTION 02680

SECTION 02726 - MANHOLE AND PRECAST VAULT CONSTRUCTION

PART 1 - GENERAL

1.01 DESCRIPTION

A. The Contractor shall furnish all tools, equipment, materials, and supplies and shall perform all labor required to complete the work as indicated on the Plans and specified herein.

B. This section covers the work necessary for the construction of manholes and precast vaults and catch basins. Manholes and vault details are as illustrated on the Plans.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 03300 - Cast-in-Place Concrete

B. Section 02200 - Earthwork

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Comply with the applicable reference specifications as specified in the General Requirements.

B. Comply with the current provisions of the following Codes and Standards.

1. Commercial Standards:

ASTM A 48	Specification for Gray Iron Castings
ASTM C 150	Specification for Portland Cement

2. Standard Specifications:

SSPWC Section 206-3	Gray Iron Casting

1.04 CONTRACTOR SUBMITTALS

A. Submittals shall be made in accordance with the General Requirements.

B. Shop Drawings: The Contractor shall furnish complete shop drawings for all precast manhole sections, vaults, catch basins, cast iron frames and covers, and appurtenances for review by the Engineer in accordance with Submittals of the General Requirements.

1.05 QUALITY ASSURANCE

A. Inspection: After installation, the CONTRACTOR shall demonstrate that all manholes, vaults, and catch basins have been properly installed, level, with tight joints, at the correct elevations and orientations, and that the backfilling has been carried out in accordance with the Contract Documents.

PART 2 - PRODUCTS

2.01 GRANULAR BASE

A. Granular base shall conform to Sections 02200 - Earthwork; and 02221 - Trenching, Backfilling and Compacting.

2.02 CONCRETE

A. Ready-mixed, conforming to ASTM C 94, Alternate B. The concrete class for manhole bases and vault shall be 560-C-3250. The concrete class for manhole and precast vault walls and top shall be 560-C-3250. Maximum size of aggregate shall be 1.5 inches. Slump shall be between 2 and 5 inches. The concrete shall attain 5,000 PSI compressive strength after 28 days.

2.03 FORMS

A. Exterior exposed surfaces shall be plywood. Others shall be matched boards, plywood, or other approved material. Provide forms on all vertical surfaces. Formwork shall comply with Section 03100 - Concrete Formwork. Trench walls, large rock, or native material will not be approved as form material.

2.04 REINFORCING STEEL

A. Conform to ASTM A 615, Grade 40, deformed bars.

2.05 POURED-IN-PLACE MANHOLES

A. Poured-in-place type manholes may be used provided all details of construction are accepted by the Engineer.

2.06 PRECAST MANHOLE SECTIONS

A. Precast manhole sections shall be a minimum of 48 inches in diameter, conforming to any details illustrated on the Plans and to ASTM C 478. Minimum wall thickness shall be 5 inches for reinforced sections and 5 1/2 inches for unreinforced sections. Provide eccentric cones for all manholes. Cones shall have same wall thickness and reinforcement as manhole section. Top and bottom of all sections shall be parallel. Manholes shall be provided without steps. Joints shall be tongue-and-groove with rubber gaskets conforming to ASTM C 443. The Contractor's attention is directed to specification for mortar hereinafter.

B. Prior to the delivery of precast manhole and vault sections to the Site, yard tests shall be conducted at the point of manufacture. The precast sections to be tested will be selected at random from the stockpiled material which is to be supplied for the job. All test specimens will be mat tested, and shall meet the permeability test requirements of ASTM C 14.

2.07 PRECAST BASE SECTIONS AND BASES

A. At the option of the Contractor, precast base sections or manhole and vault bases may be used provided all details of construction are approved by the Engineer. Base sections shall have the base slab integral with sidewalls. Base slab shall be constructed in accordance with the details illustrated on the Plans or Standard Details of the governing agency. Tie reinforcing steel to wall steel.

2.08 MANHOLE AND VAULT EXTENSIONS

A. Concrete grade rings for extensions shall be a maximum of 11 inches high and shall be approved by the Engineer before installation.

B. In general, manhole and vault extensions will be used on all manholes in roads or streets or in other locations where a subsequent change in existing grade may be likely. Extensions will be limited to a maximum height of 11 inches unless otherwise approved by the Engineer. Finish grade for manhole covers shall conform to finished ground or street surface level, unless otherwise directed by the Engineer. Manhole covers and frames shall be placed 3 inches below the finished pavement surface prior to the installation of A.C. pavement. After A.C. pavement installation is successfully completed the manhole covers and frames shall be placed to the level of the finished pavement surface. A 1-foot wide, 1 foot deep P.C.C. collar shall be placed around the manhole frame and cover 3/8 inches below the level of the finished pavement surface.

2.09 MORTAR

A. Standard premixed mortar conforming to ASTM C 387 or proportion 1 part Portland cement to 2 parts clean, well-graded sand which will pass a 1/8 inch screen. Admixtures may be used not exceeding the following percentages of weight of cement: Hydrated lime, 10 percent; diatomaceous earth or other inert materials, 5 percent. Consistency of mortar shall be such that it will readily adhere to the pipe when using the standard tongue-and-groove type joint. If the Keylock type joint is used, the consistency shall be such that excess mortar shall be forced out of the groove and support is not provided for the next precast manhole section to be placed. Mortar mixed for longer than 30 minutes shall not be used.

2.10 PREFORMED PLASTIC GASKETS

A. Preformed plastic gaskets may be used in lieu of mortar type joints and shall be Kent-Seal No. 2 manufactured by Hamilton Kent Manufacturing Company, Kent, OH; Ram-Nek, manufactured by K.T. Snyder Company, Inc., Houston, TX; or approved equal, meeting all requirements of Federal Specification SS-S-00210.

2.11 PIPE STUBOUTS FOR FUTURE SEWER OR STORMWATER CONNECTIONS

A. Pipe stubouts shall be the same type as approved for use in lateral, main, or trunk pipeline construction. Strength classifications shall be the same class as in adjacent trenches. Where there are two different classes of pipe at a manhole, the higher strength pipe will govern strength classification. Rubber gasketed watertight plugs shall be furnished with each stubout adequately braced against all hydrostatic or air test pressures.

2.12 PRECAST CONCRETE VAULT AND CATCH BASINS

A. The precast concrete vault shall be precast with a 28 day, 5000 psi minimum compressive strength concrete and designed for AASHTO H-20 loading. Minimum dimensions shall be as illustrated on the Plans. Provide openings for pipes and grating as illustrated on the Plans.

2.13 STORMWATER VAULT STEPS

A. Stormwater vault steps shall be made of minimum 3/4-inch galvanized steel bar conforming to ASTM A 36. Steps shall be 12 inch wide minimum, center-to-center of legs, and shall be drop pattern with a 2 inch drop. Bends shall be made around a 1 inch radius minimum, 2 inch radius maximum mandrel. There shall be 3 inch minimum embedment in precast concrete stormwater vault sections and 4-1/2 inch minimum projection from the face of concrete at point of embedment to the center of the step. There shall be a 2 inch hook on the embedment end. Galvanizing shall conform to ASTM A 123 and shall be accomplished after bending.

B. The installed steps shall be located so as to provide a continuous ladder with steps equally spaced vertically in the assembled stormwater vault at 12 inches ± ¾ inch. The steps shall be capable of withstanding a force of 350 pounds, applied at any place on the step and in any direction which projects from the point of application through a diameter of the step cross-section at that point, with no permanent deformation resulting. Steps shall be cast in stormwater vault sections by the manufacturer.

2.14 MANHOLE FRAMES AND COVERS

A. Cast iron or ductile iron of size and shape illustrated on the Plans. Covers shall have the word "SEWER" or "STORMWATER", as appropriate in 2 inch raised letters. Castings shall be tough, close-grained gray iron, sound, smooth, clean, free from blisters, blowholes, shrinkage, cold shuts, and all defects, and shall conform to ASTM A 48, Class 30B. Plane or grind bearing surfaces to ensure flat, true surfaces. Covers shall be true and seat within ring at all points. Frames shall have a minimum opening of 24 inches for a 4 foot diameter manhole and 30 inches for 5 foot diameter manholes.

PART 3 - EXECUTION

3.01 EXCAVATION AND BACKFILL

A. Conform to applicable portions of Section 02200 - Earthwork, and Section 02221 - Trenching, Backfilling and Compacting. Backfill around manholes and vaults.

3.02 GRANULAR BASE

A. Remove water from the excavation. Unless specified in the Plans, place a minimum of 18 inches of Class 2 Base or 1 inch rock and thoroughly compact with a mechanical or power vibrating tamper.

3.03 CONCRETE BASE

A. Construct concrete base in conformance with the details illustrated on the Plans. Vibrate to densify the concrete and screed so that the first precast manhole section to be placed has a level, uniform bearing for the full circumference.

B. Deposit sufficient mortar on base to assure watertight seal between base and manhole wall or place the first precast section of manhole in concrete base before concrete has set (preferred). First section shall be properly located and plumbed at 90-degree angles.

C. If material in bottom of trench is unsuitable for the manhole, excavate below the flow line as directed by Engineer, and backfill to required grade with 1 inch rock. Place a filter fabric material in the excavation above the level of the concrete base prior to installing the 1 inch rock.

3.04 PLACING PRECAST MANHOLE SECTIONS

A. Clean ends of sections of foreign materials. Thoroughly wet joint with water prior to placing mortar. Place mortar on groove of lower section. Set next section in place. Fill joint completely with mortar of the proper consistency. Trowel interior and exterior surfaces smooth on standard tongue-and-groove joints. Wipe or otherwise clean the excess mortar from the inside of the Keylock joint.

B. When a Keylock joint is used, it is the intent that the void between the tongue-and-groove be completely filled with mortar, and that the interior and exterior end faces of the section to be placed seat fully on the previously placed section.

C. Prevent mortar from drying out and cure by applying an approved curing compound or comparable approved method. Chip out and replace all cracked or defective mortar. Completed manholes shall be rigid and watertight.

3.05 PREFORMED PLASTIC GASKETS

A. Carefully inspect precast manhole sections to be joined. Sections with chips or cracks in the tongue shall not be used. Preformed plastic gaskets shall be installed in strict conformance with the manufacturer's recommendations. Only pipe primer furnished by the gasket manufacturer will be approved.

3.06 MANHOLE INVERT

A. Construct manhole inverts in conformance with details illustrated on the Plans, and with smooth transitions to ensure an unobstructed flow through the manhole. Remove all sharp edges or rough sections which tend to obstruct flow. Where a full section of pipe is laid through a manhole, break out the top section as indicated and cover exposed edge of pipe completely with mortar. Trowel all mortar surfaces smooth.

3.07 FLEXIBLE JOINTS

A. Provide joints in all pipe not more than 1.5 feet from manhole walls. Lay pipes entering manholes on firmly compacted granular sand backfill or rock to undisturbed native earth. Granular sand backfill or rock shall be as specified hereinbefore.

B. Where the last joint of the installed pipeline up to the manhole is more than 1.5 feet from the manhole base, a 6 inch concrete encasement shall be constructed around the entire pipe from the manhole base to within 1.5 feet of the pipe joint. The pipe encasement shall be constructed monolithically with the manhole base. Pipes installed out of the manhole shall be shortened to ensure the first joint is no more than 1.5 feet from the manhole base.

3.08 PIPE STUBOUTS FOR FUTURE SEWER AND STORMWATER CONNECTIONS

A. Install stubouts in manholes for future sewer and stormwater connections as illustrated on the Plans or as required by the Engineer. Maximum length shall be 1.5 feet outside the manhole wall. Grout pipes in precast walls or manhole base to provide watertight seal around pipes. Construct invert channels in accordance with details shown on the Plans. Provide compacted granular sand or 1 inch rock as specified hereinbefore to undisturbed earth under all stubouts.

B. Install semi-permanent plugs at the end of stubouts with gasket joints similar to sewer and stormwater pipe being used. Plugs shall be capable of withstanding all internal or external pressures without leakage. All plugs to be braced to prevent blowoffs.

3.09 PERMANENT PLUGS

A. Clean interior contact surfaces of all pipes to be cut off or abandoned as illustrated on the Plans. Construct concrete plugs at the end of all pipes 18 inches or less in diameter. Minimum length of concrete plugs shall be 8 inches. For pipe 21 inches and larger, the plugs may be constructed of common brick or concrete block. Plaster the exposed face of

block or brick plugs with mortar. All plugs shall be watertight and capable of withstanding all internal and external pressures without leakage.

3.10 MANHOLE EXTENSIONS

A. Install extensions in conformance with the details illustrated on the Plans, and to a maximum height of 12 inches unless a larger height is approved by the Engineer. Lay grade rings in mortar with sides plumb and tops level. Seal joints with mortar as specified for manhole sections. Extensions shall be watertight.

3.11 MANHOLE FRAMES AND COVERS

A. Install frames and covers on top of manholes to positively prevent all infiltration of surface or groundwater into manholes. Frames shall be set in a bed of mortar with the mortar carried over the flange of the ring as shown in the Manhole Details on the Plans. Set frames so that tops of covers are flush with surface of adjoining pavement or ground surface, unless otherwise illustrated or directed by the Engineer except within A.C. pavement surfaces. A 1 foot wide, 1 foot deep P.C.C. collar shall be placed around all manhole rings and covers. The concrete ring and manhole frames and covers in A.C. pavement areas shall be placed 3/8 inch lower than the finished A.C. pavement surface. The manhole frame and cover shall be lowered 3 inches below the finished A.C. pavement surface prior to the installation of the A.C. pavement.

3.12 MANHOLES OVER EXISTING SEWERS AND STORMWATER

A. Construct manholes over existing operating sewer and stormwater lines at locations illustrated on the Plans. Perform necessary excavation work as required to break into the existing sewer and stormwater pipeline and construct the manhole. Comply with previously-noted specifications.

B. Maintain flow through existing sewer and stormwater pipelines at all times, and protect new concrete and mortar work for a period of 7 days after concrete has been placed. Advise Engineer of plans for diverting wastewater flow and obtain Engineer's approval before starting. Engineer's approval will not relieve Contractor of responsibility for maintaining adequate capacity for flow at all times and adequately protecting new and existing work.

C. Construct the new base under the existing sewer and stormwater and the precast sections as specified herein.

D. Break out the existing pipe within the new manhole, cover the edges with mortar, and trowel smooth.

3.13 SPECIAL MANHOLES

A. Construct special manholes in conformance with applicable parts of these Specifications and as illustrated on the Plans.

3.14 PRECAST CONCRETE VAULT

A. Install precast concrete vaults at the locations illustrated on the Plans. Provide necessary excavation and backfill as specified herein and as specified by Section 02200 - Earthwork and Section 02221 - Trenching, Backfilling and Compacting.

3.15 HYDROSTATIC TESTING

A. Hydrostatic testing of manholes and vaults shall be completed in conformance with Section 02730 - Sanitary Sewer and Stormwater Gravity Pipeline System Testing.

3.16 MANHOLES - INTERIOR COATING SYSTEM

The interior of all manholes, including the manhole base surfaces and grade rings shall be coated according to the provisions of this specification:

A. Install a low temperature 100 percent solids acrylated epoxy primer system designed to provide positive cure down to 20°*F* and extremely rapid room temperature cure. The solids acrylated epoxy is to be applied as a primer material to the interior of the manhole surfaces. Apply the polyurethane system over the primer system within the surface interior of the P.C.C. manhole per the manufacturer's recommendations. The interior surface of the P.C.C. manhole shall be primed with a 1- to 3 mil thickness of 100 percent solids acrylated epoxy primer system to the abrasive grit blasted ring and to all concrete surfaces, including into the invert down to the low flow water line. Allow the primer to tack up (sticky to the touch). A 125 mil thickness polyurethane coating system shall be applied to the primer and all interior surfaces of the P.C.C. manhole after the primer has attained the required consistency.

Prior to the application of the 100 percent solids acrylated epoxy primer and polyurethane protective lining, the manhole shall be thoroughly cleaned by high water pressure blast at pressures of 34.5 MPA (5,000 PSI), minimum to 68.9 MPA (10,000 PSI) maximum. Debris from cleaning shall not be allowed to enter the pipeline system. The Contractor shall provide the necessary debris containment devices while maintaining pipeline flow. The Contractor shall remove and dispose of all debris collected from the cleaning operation per 500 1.4 of the *Greenbook* specifications.

The cured polyurethane lining shall be spark tested for pinholes with a spark tester set at 15,000 volts minimum. All pinholes shall be repaired as specified in the *Greenbook* Specification 500 2.4.9.

All pinholes in the protective lining shall be marked off on surface areas containing pinholes to a point 6 inches beyond all pinholes, primed with epoxy, and re-coated with polyurethane to a minimum additional thickness of 30 mils. Blisters, uncured lining and surface imperfections shall be completely removed and the areas re-coated with epoxy primer and polyurethane lining to a point 6 inches beyond the repair areas at a minimum thickness of 100 mils.

The epoxy primer and polyurethane lining shall meet or exceed the requirements specified in *Greenbook* Specification 303-2 and *Greenbook* Table 500 2.4.10(A) as follows:

TABLE 500-2.4.10(A)

	POLYURETHANE	**EPOXY**
Tensile Strength ASTM D 638, Type IV, MPA (PSI)	13.8 (2,000)	41.4 (6,000)
Elongation at Break, % ASTM D 638, Type IV	50	5
Wear Resistance, MG. Wt. Loss Taber Abrasion, S-17	60	100
Hardness, Shore D, Durometer ASTM D 2240	55	75
Tear Resistance, KG/MM (PPI) ASTM D 903		

	2.7 (150)	N/A
Peel Strength, Concrete, G/MM (PLI) ASTM D 903	125 (7) 1	125 (7) 1
Adhesive Strength, KPA (PSI) ASTM C 190 (Modified Briquet)	2760 (400) 1	2760 (400) 1

Test results shall be verified on a per-project basis or as required by the Engineer.

The coating system shall be approved as a submittal. The coating system shall be applied per the manufacturer's recommendations.

END OF SECTION 02726

SECTION 02770 - HDPE LINER

PART 1 - GENERAL

1.01 SCOPE

The following describes parameters for the manufacture, supply, and installation of polyethylene geomembranes. All procedures, operations, and methods shall be in strict accordance with the specifications and Plans.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 02200 - Earthwork

B. Section 02221 - Trenching, Backfilling and Compacting

C. Section 07900 – Sealants and Caulking

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Commercial Standards:

ASTM D 792	Specific gravity (relative density) and density of plastics by displacement
ASTM D 1004	Initial tear resistance of plastic sheeting
ASTM D 1238	Flow rates of thermoplastics by extrusion plastometers
ASTM D 1505	Density of plastics by the Density-Gradient technique
ASTM D 1603	Carbon black in olefin plastics
ASTM D 1898	Sampling of plastics
ASTM D 3895	Test method for oxidative induction time of polyolefins by thermal analysis
ASTM D 4833	Index Puncture Resistance of geotextiles, geomembranes and related products
ASTM D 5199	Test method for measuring nominal thickness of geotextiles and geomembrane
ASTM D 5323	Determination of 2% secant modulus for polyethylene geomembranes
ASTM D 5397	Procedure to perform a single point notched constant tensile load - Appendix (SP-NCTL) test
ASTM D 5596	Test method for microscopic evaluation of the dispersion of carbon black in polyolefin geosynthetics
ASTM D 5617	Multi-axial tension test for geosynthtics

ASTM D 5721	Practice for air-oven aging of polyolefin geomembranes
ASTM D 5885	Test method for oxidative induction time of polyolefin geosynthetics by high pressure differential scanning calorimetry
ASTM D 5994	Test method for measuring the core thickness of textured geomembranes
ASTM D 6392	Determining the integrity of nonreinforced geomembrane seams produced using thermo-fusing methods
ASTM D 6693	Determining tensile properties of nonreinforced polyethylene and nonreinforced flexible polypropylene geomembranes
GRI GM 10	Specification for the stress crack resistance of geomembrane sheet
GRI GM 11	Accelerated weathering of geomembranes using a florescent UVA-condensation exposure device
GRI GM 12	Measurement of the asperity height of textured geomembranes using a depth gauge
GRI GM 19	Seam strength and properties of thermally bonded polyolefin geomembranes
NSF / ASNI 61	Drinking Water System Components – Health Effects

1.04 QUALIFICATIONS OF CONTRACTOR WORK ACTIVITIES

A. Manufacturing:

The manufacturer shall have at least five (5) years continuous experience in manufacturing polyethylene geomembrane and/or experience totaling 10,000,000 square feet of manufactured polyethylene geomembrane.

B Installation:

The Installation Contractor shall be the manufacturer or a dealer trained to install the manufacturer's geomembrane.

Installation shall be performed under the constant direction of a field installation supervisor who shall remain on site and be responsible, throughout the liner installation, for liner layout, seaming, testing, repairs, and all other activities by the Installer. The field installation supervisor shall have installed or supervised the installation of a minimum of 2,000,000 square feet of polyethylene geomembrane. Seaming shall be performed under the direction of a master seamer (who may also be the field installation supervisor) who has seamed a minimum of 2,000,000 square feet of polyethylene geomembrane, using the same type of seaming apparatus specified for this project. The field installation supervisor and/or master seamer shall be present whenever seaming is performed.

1.05 SUBMITTALS

A. Manufacturer:

The manufacturer shall provide the following information after Contract Award, as a part of submittal information prior to liner installation:

1. List of material properties.

2. Manufacturing quality control program.

3. Copy of quality control certificates issued by the resin supplier.

4. Copy of quality control certificates for the geomembranes in conformance with Section 2.06.

B. Installation Contractor:

The installer shall provide the following written information through the Contractor prior to commencement of installation:

1. A list of completed facilities totaling a minimum of 2,000,000 square feet, which the installer has installed polyethylene geomembrane. For each installation, the following information shall be provided:

   a) Name and purpose of facility, location, and date of installation.

   b) Name of owner, design engineer, manufacturer, and name and telephone number of contact at the facility who can discuss the project.

   c) Thickness and quantity of the installed geomembrane.

2. Proposed installation panel layout.

3. Resume of the field installation supervisor and master seamer.

1.06 WARRANTY

A written Warranty shall be obtained from the manufacturer (for material) and the installation contractor (for workmanship). These documents shall warrant both the quality of the material and workmanship for a period of seven (7) years.

PART 2 - MATERIAL SPECIFICATIONS

2.01 MATERIALS

A. The geomembrane shall be High-Density Polyethylene (HDPE) or Linear Low Density Polyethylene (LLDPE).

B. Gasket material shall be neoprene, closed cell medium, ¼ inch thick, 2 inches wide with adhesive on one side, or other compatible gasket materials as required.

C. Metal battens or banding and hardware shall be 316 stainless steel.

D. Water cut-off mastic shall be Neoprene Flashing Cement.

E. Sealant shall be per Specification Section 07900 – Sealants and Caulking.

2.02 GEOMEMBRANE RAW MATERIALS

The geomembrane shall be manufactured of polyethylene resins produced in the United States and shall be compounded and manufactured specifically for the intended purpose. The resin manufacturer shall certify each lot for the following properties.

The natural polyethylene resin without the carbon black shall meet the following requirements:

Property	**Test Method**	**HDPE Requirements**	**LLDPE Requirements**
Density, g/cc	ASTM D 1505 or ASTM D 792	0.935 – 0.940	0.915 -0.926
Melt Index, g/10 min.	ASTM D 1238 Condition E	<0.4	<0.6

2.03 ROLLS

The geomembrane shall be a minimum 23.0 ft seamless width. Carbon black shall be added to the resin if the resin is not compounded for ultra-violet resistance.

The surface of the smooth geomembrane shall not have striations, roughness, pinholes, or bubbles.

The geomembrane shall be supplied in rolls. Labels on each roll shall identify the thickness of the material, the length and width of the roll, lot and roll numbers, and name of manufacturer.

The geomembrane rolls shall meet the following specifications:

Smooth HDPE Geomembrane (English units):

		Minimum Average Values			
Property	**Test Method**	**40 mil**	**60 mil**	**80 mil**	**100 mil**
Thickness, mils					
Minimum average	ASTM D 5199	40	60	80	100
Lowest Individual reading		36	54	72	90
Sheet Density, g/cc	ASTM D 1505/ D 792	0.940	0.940	0.940	0.940
Tensile Properties[1]	ASTM D 6693				
1. Yield Strength, lb/in		84	126	168	210
2. Break Strength, lb/in		152	228	304	380
3. Yield Elongation, %		12	12	12	12
4. Break Elongation, %		700	700	700	700
Tear Resistance, lb	ASTM D 1004	28	42	56	70
Puncture Resistance, lb	ASTM D 4833	72	108	144	180

Stress Crack Resistance[2], hrs	ASTM D 5397	300	300	300	300
Carbon Black Content[3], %	ASTM D 1603	2.0 – 3.0	2.0 – 3.0	2.0 – 3.0	2.0 – 3.0
Carbon Black Dispersion	ASTM D 5596	Note 4	Note 4	Note 4	Note 4
Oxidative Induction Time (OIT) Standard OIT, minutes	ASTM D 3895	100	100	100	100
Oven Aging at 85˚C High Pressure OIT - % retained after 90 days	ASTM D 5721 ASTM D 5885	80	80	80	80
UV Resistance[5] Standard OIT[6] - % retained after 1600 hrs	GRI GM 11 ASTM D 5885	50	50	50	50
Seam Properties 1. Shear Strength, lb/in 2. Peel Strength, lb/in - Hot Wedge - Extrusion Fillet	ASTM D 6392 (@ 2 in/min)	80 60 52	120 91 78	160 121 104	200 151 130
Roll Dimensions 1. Width (feet): 2. Length (feet) 3. Area (square feet): 4. Gross Weight (pounds, approx.)		23 750 17,250 3,470	23 500 11,500 3,470	23 375 8,625 3,470	23 300 6,900 3,470

1 Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction. Yield elongation is calculated using a gauge length of 3.0 inches; break elongation is calculated using a gauge length of 2.0 inches.

2 The yield stress used to calculate the applied load for the SP-NCTL test should be the mean value via MQC testing.

3 Other methods such as ASTM D 4218 or microwave methods are acceptable if an appropriate correlation can be established.

4 Carbon black dispersion for 10 different views: Nine in Categories 1 and 2 with one allowed in Category 3.

5 The condition of the test should be 20 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C.

6 UV resistance is based on percent retained value regardless of the original HP-OIT value.

Textured HDPE Geomembrane (English Units)

		Minimum Average Values			
Property	**Test Method**	**40 mil**	**60 mil**	**80 mil**	**100 mil**
Thickness, mils					

Minimum average	ASTM D 5199	38	57	76	95
Lowest Individual of 8 of 10 readings		36	54	72	90
Lowest individual of 10 readings		34	51	68	85
Asperity Height[1], mils	GRI GM 12	10	10	10	10
Sheet Density, g/cc	ASTM D 1505/ D 792	0.940	0.940	0.940	0.940
Tensile Properties[2]	ASTM D 6693				
1. Yield Strength, lb/in		84	126	168	210
2. Break Strength, lb/in		60	90	120	150
3. Yield Elongation, %		12	12	12	12
4. Break Elongation, %		100	100	100	100
Tear Resistance, lb	ASTM D 1004	28	42	56	70
Puncture Resistance, lb	ASTM D 4833	60	90	120	150
Stress Crack Resistance[3], hrs	ASTM D 5397 (App.)	300	300	300	300
Carbon Black Content[4], %	ASTM D 1603	2.0 – 3.0	2.0 – 3.0	2.0 – 3.0	2.0 – 3.0
Carbon Black Dispersion	ASTM D 5596	Note 5	Note 5	Note 5	Note 5
Oxidative Induction Time (OIT) Standard OIT, minutes	ASTM D 3895	100	100	100	100
Oven Aging at 85˚C	ASTM D 5721				
High Pressure OIT - % retained after 90 days	ASTM D 5885	80	80	80	80
UV Resistance[6]	GRI GM 11				
High Pressure OIT[7] - % retained after 1600 hrs	ASTM D 5885	50	50	50	50
Seam Properties	ASTM D 6392				
1. Shear Strength, lb/in	(@ 2 in/min)	80	120	160	200
2. Peel Strength, lb/in					
- Hot Wedge		60	91	121	151
- Extrusion Fillet		52	78	104	130
Roll Dimensions					
1. Width (feet):		23	23	23	23
2. Length (feet)		750	500	375	300
3. Area (square feet):		17,250	11,500	8,625	6,900
4. Gross Weight (pounds, approx.)		3,500	3,500	3,470	3,470

1. Of the 10 readings, 8 must be ≥ 7 mils and lowest individual reading must be ≥ 5 mils.

2. Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction. Yield elongation is calculated using a gauge length of 1.3 inches; break elongation is calculated using a gauge length of 2.0 inches.

3 The yield stress used to calculate the applied load for the SP-NCTL test should be the mean value via MQC testing.

4 Other methods such as ASTM D 4218 or microwave methods are acceptable if an appropriate correlation can be established.

5 Carbon black dispersion for 10 different views: Nine in Categories 1 and 2 with one allowed in Category 3.

6 The condition of the test should be 20 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C.

2.04 QUALITY CONTROL SPECIFICATIONS

A. Raw Materials:

1. Resin: All resins for use in geomembrane must pass a candidate pre-approval process before being eligible for use. Each incoming railcar shall be sampled by compartment with the following testing performed and compared to the manufacturer's specifications:

1. Density: ASTM D 1505

2. Melt Index: ASTM D 1238

3. Oxidative Induction Time (OIT): ASTM D 3895

B. Additives: All incoming materials are to be tested and approved prior to use with the following testing performed and compared to the manufacturer's specifications:

1. Carbon Black Content: ASTM D 1603.

2. Oxidative Induction Time (OIT): ASTM D 3895.

2.05 FINISHED PRODUCT: DURING PRODUCTION

A. Inspection: Performed on each roll during manufacturing.

1. Appearance: Sheet surface appearance shall be monitored for flaws.

2. Thickness: A full width sample shall be cut from the end of each roll for thickness measurement.

B. Roll Identification: Four tags per roll shall be used.

1. Outside the core.

2. On the core plug.

3. On the roll surface.

4. On the production roll sample.

C. Out-of-Spec. Material: Any roll not meeting the specification for any of the above inspections shall be separated from other rolls and placed on hold.

2.06 MANUFACTURER'S QUALITY CONTROL AND QUALITY ASSURANCE TESTING

A. Sampling: Full width samples shall be taken as retains from the end of each roll to the manufacturer's laboratory.

B. Testing: The geomembrane quality control testing shall meet the following frequency requirements:

Property	Test Method	Testing Frequency (min.)
Thickness (smooth sheet) (textured sheet)	ASTM D 5199 ASTM D 5994	per roll
Asperity Height (textured sheet only) Alternate the measurement side for double-sided textured sheet	GRI GM 12	every second roll
Sheet Density	ASTM D 1505/ D 792	200,000 lb (90,000 kg)
Tensile Properties 1. Yield Strength 2. Break Strength 3. Yield Elongation 4. Break Elongation	ASTM D 6693	20,000 lb (9,000 kg)
2% Modulus (LLDPE only)	ASTM D 5323	per each formulation
Tear Resistance	ASTM D 1004	45,000 lb (20,000 kg)
Puncture Resistance	ASTM D 4833	45,000 lb (20,000 kg)
Axi-Symetric Break Strain (LLDPE only)	ASTM D 5617	per each formulation
Stress Crack Resistance (HDPE only)	ASTM D 5397 (App.)	per GRI GM 10
Carbon Black Content	ASTM D 1603	20,000 lb (9,000 kg)
Carbon Black Dispersion	ASTM D 5596	45,000 lb (20,000 kg)
Oxidative Induction Time (OIT) Standard OIT	ASTM D 3895	200,000 lb (90,000 kg)

Oven Aging at 85˚C High Pressure OIT	ASTM D 5721 ASTM D 5885	per each formulation
UV Resistance High Pressure OIT	GRI GM 11 ASTM D 5885	per each formulation

C. Welding Rod: A sample of welding rod shall be tested at the frequency of once per 25 rolls of welding rod. The following tests shall be performed on the sample:

1. Diameter: ASTM D 5199

2. Density: ASTM D 1505

3. Melt Index: ASTM D 1238

4. Carbon Black Content: ASTM D 1603

D. Reporting: Results from the testing shall be reviewed by the quality control manager. Material that does not meet specifications shall be identified and placed on hold. The test data shall then be transferred to the product data file for roll certification.

PART 3.0 - GEOMEMBRANE INSTALLATION

3.01 MATERIALS LOGISTICS

A. The geomembrane rolls shall be shipped by flatbed trailer to the job site. The geomembrane shall be stored so as to be protected from puncture, dirt, grease, moisture and excessive heat. Damaged material shall be stored separately for repair or replacement. The rolls shall be stored on a prepared smooth surface (not wooden pallets) and should not be stacked more than two rolls high.

3.02 EARTHWORK

A. General: The Owner's Representative shall inspect the subgrade preparation. Prior to liner installation the subgrade shall be compacted in accordance with the project specifications. Weak or compressible areas which cannot be satisfactorily compacted should be removed and replaced with properly compacted fill. All surfaces to be lined shall be smooth, free of all foreign and organic material, sharp objects, or debris of any kind. The subgrade shall provide a firm, unyielding foundation with no sharp changes or abrupt breaks in grade. Standing water or excessive moisture shall not be allowed.

The installer, on a daily basis, shall approve the surface on which the geomembrane will be installed. After the supporting soil surface has been approved, it shall be the installer's responsibility to indicate to the Owner's Representative any changes to its condition that may require repair work.

B. Anchor Trench: The anchor trench shall be excavated to the line, grade, and width shown on the Plans, prior to liner system placement. Slightly rounded corners shall be provided in the trench to avoid sharp bends in the geomembrane.

3.03 METHOD OF PLACEMENT

A. The rolls shall be deployed using a spreader bar assembly attached to a loader bucket or by other methods approved by the Owner's Representative.

The installer shall be responsible for the following:

1. Equipment or tools shall not damage the geomembrane during handling, transportation and deployment.

2. Personnel working on the geomembrane shall not smoke or wear damaging shoes.

3. The method used to unroll the panels shall not cause scratches or crimps in the geomembrane and shall not damage the supporting soil.

4. Adequate loading (e.g., sand bags or similar items that will not damage the geomembrane) shall be placed to prevent uplift by wind (in case of high winds, continuous loading is recommended along edges of panels to minimize risk of wind flow under the panels).

B. Weather Conditions: Geomembrane deployment shall proceed between ambient temperatures of 32° F and 104° F. Placement can precede below 32° F only after it has been verified by the inspector that the material can be seamed according to the specification. Geomembrane placement shall not occur during any precipitation, in the presence of excessive moisture (e.g., fog, rain, dew) or in the presence of excessive winds, as determined by the installation supervisor.

3.04 FIELD SEAMING

Approved seaming processes are fusion and extrusion welding. On side slopes, seams shall be oriented in the general direction of maximum slope, i.e., oriented down, not across the slope. In corners and odd-shaped geometric locations, the number of field seams shall be minimized.

No base T-seam shall be closer than 5 feet from the toe of the slope. Seams shall be aligned with the least possible number of wrinkles and "fishmouths". If a fishmouth or wrinkle is found, it shall be relieved and cap-stripped.

A. Seam Overlap: Geomembrane panels must have a finished minimum overlap of 4 inches for fusion welding and 6 inches for extrusion welding.

Cleaning solvents may not be used unless the product is approved by the liner manufacturer.

B. Test Seams: Field test seams shall be conducted on the liner to verify that seaming conditions are satisfactory. Test seams shall be conducted at the beginning of each seaming period and at least once every 4 hours, for each seaming apparatus and personnel used that day.

All test seams shall be made in contact with the subgrade. Welding rod used for extrusion welding shall have the same properties as the resin used to manufacture the geomembrane. The test seam samples shall be 10 feet long for fusion welding and 3 feet long for extrusion welding with the seam centered lengthwise. Three specimens shall be cut from each end of the test seams by the Owner's Representative. The Owner's Representative shall use a tensiometer to test 3 specimens for shear and 3 specimens for peel. Each specimen shall be one inch wide with a grip separation of 4 inches plus the width of the seam. The seam shall be centered between the clamps. The rate of grip separation shall be 2 inches per minute.

C. Assessment of Seam Test Results: For both smooth and textured seams the strength of two out of three 1.0 inch (25 mm) wide strip specimens should meet or exceed values given in this specification. The third must meet or exceed 80% of the given values. The shear percent elongation should exceed 50%. The assumed gauge length is considered to

be the unseamed sheet material on either side of the welded area. Elongation measurements should be omitted for field testing. In addition, the peel separation should not exceed 25% based on the proportion of area of separated bond to the area of the original bonding. Regarding the locus-of-break patterns of the different seaming methods in shear and peel, the following are unacceptable break codes per their description in the ASTM D 6392. In this regard, SIP is an acceptable break code.

1. Unacceptable Break Codes:

   Hot Wedge: AD and AD-BRK > 25%

   Extrusion Fillet: AD1, AD2 and AD-Weld (unless strength is achieved)

D. Non-Destructive Seam Testing: The installer shall non-destructively test all field seams over their full length.

1. Vacuum Box Testing: Equipment for testing extrusion seams shall be comprised of the following:

   a. A vacuum box assembly consisting of a rigid housing, a transparent viewing window, a soft rubber gasket attached to the bottom, port hole or valve assembly, and a vacuum gauge.

   b. Soapy solution in a plastic bucket with a mop.

   The following procedures shall be followed by the installer:

   a. Excess sheet overlap shall be trimmed away.

   b. Wet a strip of geomembrane approximately 12 inches wide by the length of box with the soapy solution.

   c. Place the box over the wetted area and compress.

   d. Create a vacuum of 3 - 5 PSI.

   e. Ensure that a leak tight seal is created.

   f. For a period of approximately 10 seconds, examine the geomembrane through the viewing window for the presence of animated soap bubbles.

   g. If no animated bubbles appear after 10 seconds, close the vacuum valve and open the bleed valve, move the box over the next adjoining area with a minimum 3 inches overlap and repeat the process.

   h. All areas where animated soap bubbles appear shall be marked, repaired and then retested.

   The following procedures shall apply to locations where seams cannot be non-destructively tested.

   a. If the seam is accessible to testing equipment prior to final installation, the seam shall be non-destructively tested prior to final installation.

b. If the seam cannot be tested prior to final installation, the seams shall be spark tested according to the spark tester manufacturer's procedures.

2. Air Pressure Testing (For Double Fusion Seams Only): Equipment for testing double fusion seams shall be comprised of the following:

a. An air pump equipped with pressure gauge capable of generating and sustaining a pressure between 25 and 30 PSI.

b. A pressure gauge equipped with a sharp hollow needle.

The following procedures shall be followed by the installer:

a. Seal one end of the seam to be tested.

b. Insert needle or other approved pressure feed device through the sealed end of the channel created by the double wedge fusion weld.

c. Energize the air pump to verify the unobstructed passage of air through the channel.

d. Seal the other end of the channel.

e. Energize the air pump to a pressure between 25 and 30 psi, close valve, allow 2 minutes for the injected air to come to equilibrium in the channel, and sustain pressure for approximately 5 minutes.

f. If loss of pressure exceeds 4 psi, or pressure does not stabilize, locate faulty area, repair and retest.

g. If pressure does not drop below the acceptable value after five minutes, cut the air channel open at the opposite end from the pressure gauge. The air channel should deflate immediately indicating that the entire length of the seam has been tested.

E. Destructive Seam Testing: Destructive seam testing should be minimized to preserve the integrity of the liner. The installer shall provide the Owner's Representative with one destructive test sample per project specifications (usually once per 500 feet of seam length) from a location specified by the Owner's Representative.

1. Sampling Procedure: In order to obtain test results prior to completion of liner installation, samples shall be cut by the installer as the seaming progresses. The installer shall also record the date, location, and pass or fail description. All holes in the geomembrane resulting from obtaining the seam samples shall be immediately patched and vacuum tested.

2. Size and Disposition of Samples: The samples shall be 12 inches wide by 36 inches long with the seam centered lengthwise. The sample shall be cut into three equal-length pieces, one to be given to the Owner's Representative, one to be given to the Owner and one to the installer.

3. Field Laboratory Testing: The Owner's Representative shall test ten 1-inch wide specimens from his sample, five specimens for shear strength and five for peel strength.

4. Independent Laboratory Testing: The Owner, at its discretion and expense, may send seam samples to a laboratory for testing. The test method and procedures to be used by the independent laboratory shall be the same as used in field testing.

5. Procedures for Destructive Test Failure: The following procedures shall apply whenever a sample fails the field destructive test:

   a. The installer shall cap strip the seam between the failed location and any passed test locations.

   b. The installer can retrace the welding path to an intermediate location (usually 10 feet from the location of the failed test), and take a sample for an additional field test. If this test passes, then the seam shall be cap stripped between that location and the original failed location. If the test fails, then the process is repeated.

   c. Over the length of seam failure, the installer shall either cut out the old seam, reposition the panel and reseam, or add a cap strip.

F. Defects and Repairs: All seams and non-seam areas of the geomembrane shall be inspected by the Owner's Representative for defects, holes, blisters, undispersed raw materials, and any sign of contamination by foreign matter. The surface of the geomembrane shall be clean at the time of inspection.

1. Evaluation: Each suspect location in seam and non-seam areas shall be non-destructively tested as appropriate in the presence of the Owner's Representative. Each location that fails the non-destructive testing shall be marked by the Owner's Representative, and repaired accordingly.

2. Repair Procedures:

   a. Defective seams shall be cap stripped or replaced.

   b. Small holes shall be repaired by extrusion welding a bead of extrudate over the hole. If the hole is larger than ¼-inch, it shall be patched.

   c. Tears shall be repaired by patching. If the tear is on a slope or an area susceptible to stress and has a sharp end it must be rounded prior to patching.

   d. Blisters, large cuts and undispersed raw materials shall be repaired by patches.

   e. Patches shall be completed by extrusion welding. The weld area shall be ground no more than 10 minutes prior to welding. No more than 10% of the thickness shall be removed by grinding. Welding shall commence where the grinding started and must overlap the previous seam by at least 2 inches. Reseaming over an existing seam without regrinding shall not be permitted. The welding shall restart by grinding the existing seam and rewelding a new seam.

      Patches shall be round or oval in shape, made of the same geomembrane, and extend a minimum of 6 inches beyond the edge of defects.

3. Verification of Repairs: Each repair shall be non-destructively tested. Repairs that pass the non-destructive test shall be taken as an indication of an adequate repair. Failed tests indicate that the repair shall be repeated and retested until passing test results are achieved.

   The Owner's Representative shall keep daily documentation of all non-destructive and destructive testing. This documentation shall identify all seams that initially failed the test and include evidence that these seams were repaired and successfully retested.

3.05 BACKFILLING OF ANCHOR TRENCH

The geomembrane in the anchor trench shall be covered as soon as possible. The covering operation shall not damage the geomembrane. The cover soil material shall be free of foreign and organic material, sharp objects, or debris of any kind, which could potentially damage the geomembrane. No construction equipment or machinery shall operate directly on the geomembrane. The use of lightweight machinery (i.e., generator, etc.) with low ground pressure is allowed.

The anchor trench shall be backfilled by the Earthwork Contractor. Trench backfill material shall be placed and compacted in accordance with the project specifications.

Care shall be taken when backfilling the trenches to prevent any damage to the geomembrane. If damage occurs, it shall be repaired prior to backfilling.

3.06 GEOMEMBRANE ACCEPTANCE

The installer shall retain all ownership and responsibility for the geomembrane until accepted by the Owner's Representative.

Final acceptance is when all of the following conditions are met:

A. Installation is finished.

B. Verification of the adequacy of all field seams and repairs, including associated testing, is complete.

END OF SECTION 02770

SECTION 02780 - GEOTEXTILE FABRIC

PART 1 - GENERAL

1.01 DESCRIPTION

A. Geotextile to prevent mixing of a subgrade soil and an aggregate cover material (subbase, base, select embankment, etc.). The separation application is appropriate for pavement structures constructed over soils with a California Bearing Ratio (CBR) equal to or greater than 3 (CBR $\geq$ 3) (shear strength greater than approximately 90 kPa) or as illustrated on the Plans. This specification also applies to situations other than beneath pavements and concrete structures where separation of two dissimilar materials is required but where water seepage through the geotextile is not a critical function.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 02140 - Dewatering

B. Section 02200 - Earthwork

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. AASHTO Standards:

1. T88 - Particle Size Analysis of Soils

2. T90 - Determining the Plastic Limit and Plasticity Index of Soils

3. T99 - The Moisture-Density Relations of Soils Using a 5.5 lb (2.5 kg) Rammer and a 12-inch (305mm) Drop

4. M288-96: - Geotextile Specification for Highway Applications

B. American Society for Testing and Materials (ASTM):

1. D 123 - Standard Terminology Relating to Textiles

2. D 276 - Test Method for Identification of Fibers in Textiles

3. D 3786 - Standard Test Method for Hydraulic Bursting Strength of Knitted Goods and Nonwoven Fabrics

4. D 4354 - Practice for Sampling of Geosynthetics for Testing

5. D 4355 - Test Method for Deterioration of Geotextiles from Exposure to Ultraviolet Light and Water (Xenon-Arc Type Apparatus)

6. D 4439 - Terminology for Geotextiles

7. D 4491 - Test Methods for Water Permeability of Geotextiles by Permittivity

8. D 4533 - Test Method for Index Trapezoid Tearing Strength of Geotextiles

9. D 4595 - Test Method for Tensile Properties of Geotextiles by the Wide-Width Strip Method

10. D 4632 - Test Method for Grab Breaking Load and Elongation of Geotextiles

11. D 4751 - Test Method for Determining Apparent Opening Size of a Geotextile

12 D 4759 - Practice for Determining the Specification Conformance of Geosynthetics

13. D 4833 - Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products

14. D 4873 - Guide for Identification, Storage, and Handling of Geotextiles

15. D 5141 - Test Method to Determine Filtering Efficiency and Flow Rate for Silt Fence Applications Using Site Specific Soils

C. Federal Highway Administration (FHWA): Geosynthetic Design and Construction Guidelines, Publication No. FHWA HI-95-038, May 1995

D. American Association of Laboratory Accreditation (A2LA)

E. Geosynthetic Accreditation Institute (GAI) - Laboratory Accreditation Program (LAP)

F. National Transportation Product Evaluation Program (NTPEP)

1.04 CONTRACTOR SUBMITTALS

A. The Contractor shall provide to the Engineer a certificate stating the name of the manufacturer, product name, style number, chemical composition of the filaments or yarns and other pertinent information to fully describe the geotextile. The Certification shall state that the furnished geotextile meets MARV requirements of the specification as evaluated under the manufacturer's quality control program. The Certification shall be attested to by a person having legal authority to bind the manufacturer.

Minimum Average Roll Value (MARV): Property value calculated as typical minus two standard deviations. Statistically, it yields a 97.7 percent degree of confidence that any sample taken during quality assurance testing will exceed value reported.

1.05 QUALITY ASSURANCE

A. Geosynthetic Accreditation Institute (GAI) - Laboratory Accreditation Program (LAP).

B. American Association for Laboratory Accreditation (A2LA).

1.06 DELIVERY, STORAGE AND HANDLING

A. Geotextiles labeling, shipment, and storage shall follow ASTM D 4873. Product labels shall clearly show the manufacturer or supplier name, style name, and roll number.

B. Each geotextile roll shall be wrapped with a material that will protect the geotextile from damage due to shipment, water, sunlight, and contaminants.

C. During storage, geotextile rolls shall be elevated off the ground and adequately covered to protect them from the following: site construction damage, precipitation, extended ultraviolet radiation including sunlight, chemicals that are strong acids or strong bases, flames including welding sparks, excess temperatures, and any other environmental conditions that may damage the physical property values of the geotextile.

PART 2 - PRODUCTS

2.01 MATERIALS

A. The geotextile shall be manufactured with fibers consisting of long-chain synthetic polymers composed of at least 95 percent by weight of polyolefins or polyesters. They shall form a stable network such that the filaments or yarns retain their dimensional stability relative to each other, including selvages.

B. The geotextile shall meet the requirements of Table 1. All numeric values in Table 1 except AOS represent MARV in the weakest principal direction. Values for AOS represent maximum average roll values.

C. Table 1 - Separation Geotextile

Property	**Test Method**	**Units**	**Elongation < 50%[1]**
Grab Tensile Strength	ASTM D 4632	N (lbs)	1100 (247)
Sewn Seam Strength[2]	ASTM D 4632	N (lbs)	990 (222)
Tear Strength	ASTM D 4533	N (lbs)	400 (90)
Puncture Strength	ASTM D 4833	N (lbs)	500 (112)
Burst Strength	ASTM D 3786	kPa (PSI)	3500 (507)
Permittivity	ASTM D 4991	sec^{-1}	0.02
Apparent Opening Size	ASTM D 4751	mm (US Sieve)	0.60 max (30)
Ultraviolet Stability (after 500 hrs)	ASTM D 4355	%	50

[1]A measured in accordance with ASTM D 4632.

[2]When sewn seams are required. Refer to Section 3 - Execution for overlap/seam requirements.

2.02 QUALITY CONTROL

A. Manufacturing Quality Control: Testing shall be performed at a laboratory accredited by GAI-LAP and A2LA for tests required for the geotextile, at frequency meeting or exceeding ASTM D 4354.

B. Geotextile properties, other than Sewn Seam Strength, Burst Strength, and Ultraviolet Stability, shall be tested by NTPEP to verify conformance with this Specification.

C. Sewn Seam Strength shall be verified based on testing of either conformance samples obtained using Procedure A of ASTM D 4354, or based on manufacturer's certifications and testing of quality assurance samples obtained using Procedure B of ASTM D 4354. A lot size for conformance or quality assurance sampling shall be considered to be the shipment quantity of the given product or a truckload of the given product, whichever is smaller.

D. Ultraviolet Stability shall be verified by an independent laboratory on the geotextile or a geotextile of similar construction and yarn type.

2.03 MANUFACTURERS

A. Product: MIRAFI 600X
Mirafi Construction Products
365 South Holland Drive
Pendergrass, GA 30567
1-888-795-0808 1-706-593-2226 1-706-693-2083, FAX
www.mirafi.com

B. Product: GEOTEX 250 ST
Propex, Inc.
6025 Lee Highway, Suite 425
P. O. Box 22788
Chattanooga, TN 37422
1-800-621-1273 1-423-890-0444 1-423-899-7619, FAX
www.geotextile.com

C. Or an approved equal.

PART 3 - EXECUTION

3.01 PREPARATION

A. The installation site shall be prepared by clearing, grubbing, and excavation or filling the area to the design grade. This includes removal of topsoil and vegetation.

3.02 INSTALLATION

A. The geotextile shall be laid smooth without wrinkles or folds on the prepared subgrade in the direction of construction traffic. Adjacent geotextile rolls shall be overlapped, sewn or joined per manufacturer's recommendations or as listed in the table below, the more stringent shall apply when conflicting. See table below for overlap requirements.

Soil CBR	**Method of Joining**
Greater than 3	300 - 450 mm (12 - 18 in) overlap
1 - 3	600 - 1000mm (24 - 40 in) overlap
0.5 - 1	1000mm (40 in) overlap or sewn
Less than 0.5	Sewn
All roll ends	1000mm (40 in) overlap or sewn

B. On curves, the geotextile may be folded or cut to conform to the curves. The fold or overlap shall be in the direction of construction and held in place by pins, staples, or piles of fill or rock.

C. Prior to covering, the geotextile shall be inspected by a certified inspector of the Engineer to ensure that the geotextile has not been damaged during installation. Damaged geotextiles, as identified by the Engineer, shall be repaired immediately. Cover the damaged area with a geotextile patch which extends an amount equal to the required overlap beyond the damaged area.

D. The subbase shall be placed by end dumping onto the geotextile from the edge of the geotextile, or over previously placed subbase aggregate. Construction vehicles shall not

be allowed directly on the geotextile. The subbase shall be placed such that at least the minimum specified lift thickness shall be between the geotextile and equipment tires or tracks at all times. Turning of vehicles shall not be permitted on the first lift above the geotextile.

E. On subgrades having a CBR value of less than 1, the subbase aggregate should be spread in its full thickness as soon as possible after dumping to minimize the potential of localized subgrade failure due to overloading of the subgrade.

F. Any ruts occurring during construction shall be filled with additional subbase material, and compacted to the specified density.

G. If placement of the backfill material causes damage to the geotextile, the damaged area shall be repaired as previously described above. The placement procedure shall then be modified to eliminate further damage from taking place.

END OF SECTION 02780

SECTION 03100 - CONCRETE FORMWORK

PART 1 - GENERAL

1.01 DESCRIPTION

A. The Contractor shall provide concrete formwork, bracing, shoring, supports, and false work, in accordance with the Contract Documents.

B. Work included in this Section: Principal items are:

1. Furnishing, erection, and removal of forms.

2. Shoring and bracing of formwork.

3. Setting of embedded items and pipe sleeves for mechanical and electrical work under direction of respective trade.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. The Work of the following Sections apply to the Work of this Section. Other Sections, not referenced below, shall also apply to the extent required for proper performance of the Work.

1. Section 03200 - Reinforcement Steel

2. Section 03290 - Joints in Concrete Structures

3. Section 03300 - Cast-in-Place Concrete

4. Section 03315 - Grout

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Except as otherwise indicated in this Section of the Specifications, the Contractor shall comply with the latest adopted edition of the Standard Specifications for Public Works Construction (SSPWC), together with the latest adopted editions of the Regional Amendments.

B. The current edition of the Uniform Building Code (UBC) of International Conference of Building Officials (ICBO).

C. Except as otherwise indicated, the current editions of the following apply to the Work of this Section:

1.	PS 1	U.S. Product Standard for Concrete Forms, Class 1
2.	PS 20	American Softwood Lumber Standard
3.	ACI 117	Standard Tolerances for Concrete Construction and Materials
4.	ACI 347	Recommended Practice for Concrete Formwork

1.04 CONTRACTOR SUBMITTALS

A. The Contractor shall, in accordance with the requirements in the Specification Section 01300 – Contractor Submittals, submit detailed drawings of the false work proposed to be used. Such drawings shall be in sufficient detail to indicate the general layout, sizes of members, anticipated stresses, grade of materials to be used in the false work, means of protecting existing construction which supports false work, and typical soil conditions.

B. The Contractor shall, in accordance with the requirements in the Specification Section 01300 – Contractor Submittals, submit the following:

1. Form ties and all related accessories, including taper tie plugs, if taper ties are used.

2. Form gaskets.

C. The Contractor shall provide concrete construction joints and expansion joints of the types and locations indicated on the Plans. The Contractor shall submit shop drawings showing the proposed location and type of required construction for any joints not shown on the Plans, and the sequence of forming and concrete placing operations.

D. Forms and false work to support the roof and floor slabs shall be designed for the total dead load, plus a live load of 50 PSF (minimum). The minimum design load for combined dead and live loads shall be 100 PSF.

E. The Contractor shall design formwork prior to fabrication, placing the order, or use on the jobs.

F. The Contractor shall design joints in forms to remain mortar-tight and withstand placing pressures without bulging outward or creating surface patterns.

G. Calculations shall be signed and sealed by a Professional Civil or Structural Engineer registered in the State of California for both the forming system and the stresses induced on the form system.

H. Suitable and effective means shall be provided for holding adjacent edges and end panels and sections tightly together and in accurate alignment so as to prevent the formation of ridges, fins, offsets or similar surface defects in the finished concrete. The forms shall be tight so as to prevent the loss of water, cement, and fines during placing and vibrating of the concrete.

1.05 QUALITY ASSURANCE

A. The Contractor shall comply with the requirements of California Division of Occupational Health and Safety Construction Safety Orders Section 1717 and OSHA Part 1926, Section 1926.701 that apply to the Work of this Section. The Contractor shall prepare and maintain at least one copy of the required Plans at the site. Design of the structures shown on the Plans does not include any allowance or consideration for imposed construction loads. The Contractor shall provide forms, shoring and false work adequate for imposed live and dead loads, including equipment, height of concrete drop, concrete and foundation pressures, stresses, lateral stability, and other safety factors during construction.

B. Tolerances: The Contractor shall employ formwork complying with ACI 347 Guide to Formwork for Concrete, except as exceeded by the requirements of regulatory agencies, or as otherwise indicated or specified. The Contractor shall design and construct formwork to produce finished concrete conforming to tolerances given in ACI 117.

PART 2 - PRODUCTS

2.01 GENERAL

A. Except as otherwise expressly accepted by the Engineer, all lumber brought on the Site for use as forms, shoring, or bracing shall be new material. All forms shall be smooth surface forms and shall be of the following materials:

Walls:	Steel or plywood panel
Columns:	Steel, plywood or fiberglass
Roof and Floor:	Plywood
All Other Work:	Steel panels, plywood or tongue and groove lumber

B. Form materials which may remain or leave residues on or in the concrete shall be classified as acceptable for potable water use by the Environmental Protection Agency within 30 days of application or use.

2.02 FORM AND FALSE WORK MATERIALS

A. Materials for concrete forms, formwork, and false work shall conform to the following requirements:

1. Lumber shall be Douglas Fir or Southern Yellow Pine, construction grade or better, in conformance with U.S. Product Standard PS 20.

2. Plywood for concrete formwork shall be new, waterproof, synthetic resin bonded, exterior type Douglas Fir or Southern Yellow Pine plywood manufactured especially for concrete formwork and shall conform to the requirements of PS 1 for Concrete Forms, Class I, and shall be edge sealed.

3. Form materials shall be metal, wood, plywood, or other approved material that will not adversely affect the concrete and will facilitate placement of concrete to the shape, form, line, and grade shown. Metal forms shall be an approved type that will accomplish such results. Wood forms for surfaces to be painted shall be Medium Density Overlaid plywood, MDO Ext. Grade.

2.03 FORM TIES

A. Form ties with integral waterstops shall be provided with a plastic cone or other suitable means for forming a conical hole to ensure that the form tie may be broken off back of the face of the concrete. The maximum diameter of removable cones for rod ties, or of other removable form-tie fasteners having a circular cross-section, shall not exceed 1-1/2 inches; and all such fasteners shall be such as to leave holes of regular shape for reaming. Form ties shall be Burke Penta-Tie System by The Burke Company; Richmond Snap-Tys by the Richmond Screw Anchor Company; or equal.

B. Form ties for water-retaining structures shall have integral waterstops. Removable taper ties may be used when approved by the Engineer. A preformed neoprene or polyurethane tapered plug sized to seat at the center of the wall shall be inserted in the hole left by the removal of the taper tie. Use Burke Taper-Tie System by The Burke Company; Taper-Ty by the Richmond Screw Anchor Company; or equal.

2.04 FORM COATING

A. Non-grainrising and nonstaining resin or polymer type that will not leave residual matter on surface of concrete or adversely effect bonding to concrete of paint, plaster, mortar,

protective coatings, waterproofing or other applied materials. Coatings containing mineral oils, paraffins, waxes or other nondrying ingredients, are not permitted. For concrete surfaces contacting potable stored water, use only coatings and form-release agents that are completely nontoxic.

2.05 FORM JOINT SEALERS

A. For joints between form panels, use resilient foam rubber strips, non-hardening plastic-type caulking compound free of oil, or waterproof pressure-sensitive plastic tape of minimum 8 mil thickness and 2 inches width. For form tie holes, use rubber plugs, plastic caulking compound, or equal.

PART 3 - EXECUTION

3.01 GENERAL

A. Forms to confine the concrete and shape it to the required lines shall be used wherever necessary. The Contractor shall assume full responsibility for the adequate design of all forms, and any forms which are unsafe or inadequate in any respect shall promptly be removed from the Work and replaced at no increased cost to the Owner. The Contractor shall provide worker protection from protruding reinforcement bars in accordance with applicable safety codes. A sufficient number of forms of each kind shall be provided to permit the required rate of progress to be maintained. The design and inspection of concrete forms, false work, and shoring shall comply with applicable local, state and Federal regulations. Plumb and string lines shall be installed before concrete placement and shall be maintained during placement. Such lines shall be used by Contractor's personnel and by the Engineer and shall be in sufficient number and properly installed. During concrete placement, the Contractor shall continually monitor plumb and string line form positions and immediately correct deficiencies.

B. Concrete forms shall conform to the shape, lines, and dimensions of members as called for on the Drawings, and shall be substantial, free from surface defects, and sufficiently tight to prevent leakage. Forms shall be properly braced or tied together to maintain their position and shape under a load of freshly placed concrete. If adequate foundation for shores cannot be secured, trussed supports shall be provided.

C. Unless otherwise indicated, exterior corners in concrete members shall be provided with ¾ inch chamfers. Re-entrant corners in concrete members shall not have fillets unless otherwise indicated.

D. The Contractor shall notify the Engineer at least 48 hours prior to concrete placement so the completed formwork can be inspected.

E. Final inspection will be made only after all formwork, embeds, blowouts, screeds, ties, final adjustments, and related work have been completed by the Contractor.

F. The Contractor shall correct defective work identified by the Engineer, prior to delivery of the concrete.

G. Neither the review of the Contractor's drawings nor inspection of forms by the Engineer shall relieve the Contractor of responsibility for the adequacy of the forms nor from the necessity for remedying all defects which may develop or become apparent with use. The Engineer may at any time condemn any section or sections of the forms found deficient. The Contractor shall promptly remove the condemned forms from the Work and replace them.

3.02 FORM DESIGN

A. All forms shall be true in every respect to the required shape and size, shall conform to the established alignment and grade, and shall be of sufficient strength and rigidity to maintain their position and shape under the loads and operations incident to placing and vibrating the concrete. Suitable and effective means shall be provided on all forms for holding adjacent edges and ends of panels and sections tightly together and in accurate alignment so as to prevent the formation of ridges, fins, offsets, or similar surface defects in the finished concrete. Plywood, 5/8 inch and greater in thickness, may be fastened directly to studding if the studs are spaced close enough to prevent visible deflection marks in the concrete. The forms shall be tight so as to prevent the loss of water, cement and fines during placing and vibrating of the concrete. Specifically, the bottom of wall forms that rest on concrete footings or slabs shall be provided with a gasket to prevent loss of fines and paste during placement and vibration of concrete. Such gasket may be a 1- to 1-1/2 inch diameter polyethylene rod held in position to the underside of the wall form. Adequate clean-out holes shall be provided at the bottom of each lift of forms. The size, number, and location of such clean-outs shall be as acceptable to the Engineer. Whenever concrete cannot be placed from the top of a wall form in a manner that meets the requirements of the Contract Documents, form windows shall be provided in the size and spacing needed to allow placement of concrete to the requirements of Section 03300 - Cast-in-Place Concrete. The size, number, and location of such form windows shall be as acceptable to the Engineer.

B. Wall Forms:

1. All walls shall be formed by methods acceptable to the Engineer and to the correct elevations and location illustrated on the Plans.

2. Pouring Openings:

a) The minimum pouring opening size shall be 18” x 18”.

b) The bottom of the lower openings shall be no more than 48 inches from the top of the wall-footing.

c) The horizontal centerline distance between such openings shall not exceed 96 inches nor shall the distance between the nearest opening and the bulkhead for the vertical joint exceed 36 inches.

d) The vertical centerline distance between horizontal rows of openings shall not exceed 96 inches.

e) Under no circumstances shall forming be such that the drop of concrete in the forms will exceed 4 feet in any one place.

3.03 CONSTRUCTION

A. Vertical Surfaces: All vertical surfaces of concrete members shall be formed, except where placement of the concrete against the ground is shown. Not less than 1 inch of concrete shall be added to the thickness of the concrete member as shown where concrete is permitted to be placed against trimmed ground in lieu of forms. Such permission will be granted only for members of comparatively limited height and where the character of the ground is such that it can be trimmed to the required lines and will stand securely without caving or sloughing until the concrete has been placed.

B. Construction Joints: Concrete construction joints will not be permitted at locations other than those shown or specified, except as may be acceptable to the Engineer. When a second lift is placed on hardened concrete, special precautions shall be taken in the way of the number, location, and tightening of ties at the top of the old lift and bottom of the new to prevent any unsatisfactory effect whatsoever on the concrete. Pipe stubs and anchor bolts shall be set in the forms where required.

C. Form Ties:

1. Embedded Ties: Holes left by the removal of form tie cones shall be reamed with suitable toothed reamers so as to leave the surface of the holes clean and rough before being filled with non-shrink grout as specified for "Finish of Concrete Surfaces" in Section 03315 - Grout. Wire ties for holding forms will not be permitted. No form-tying device or part thereof, other than metal, shall be left embedded in the concrete. Ties shall not be removed in such manner as to leave a hole extending through the interior of the concrete members. The use of snap-ties which cause spalling of the concrete upon form stripping or tie removal will not be permitted. If steel panel forms are used, rubber grommets shall be provided where the ties pass through the form in order to prevent loss of cement paste. Where metal rods extending through the concrete are used to support or to strengthen forms, the rods shall remain embedded and shall terminate not less than 1 inch back from the formed face or faces of the concrete.

2. Removable Ties: Where taper ties are approved for use, the larger end of the taper tie shall be on the wet side of walls in water retaining structures. After the taper tie is removed, the hole shall be thoroughly cleaned and roughened for bond. A precast neoprene or polyurethane tapered plug shall be located at the wall centerline. The hole shall be completely filled with non-shrink grout for water bearing and below-grade walls. The hole shall be completely filled with non-shrink or regular cement grout for above-grade walls which are dry on both sides. Exposed faces of walls shall have the outer 2 inches of the exposed face filled with a cement grout which shall match the color and texture of the surrounding wall surface.

D. Embedded Items:

1. Before the placement of concrete within the forms, each trade having embedded items, including waterstops within the forms and affected by the pour, shall certify that all items are properly located and braced. This certification shall be provided by the Contractor to the Engineer at least 48 hours in advance of placement.

3.04 EMBEDDED PIPING AND ROUGH HARDWARE

A. The Contractor shall consult with all trades which require openings for the passage of pipes, conduits and other inserts, and properly and accurately install the necessary pipe sleeves, anchors, or other required inserts, and properly size the equipment pads. The Contractor shall reinforce openings as indicated and required. The Contractor shall locate conduits or pipes so as not to reduce the strength of the construction, and in no case, place pipes, other than conduits in a slab 4-1/2 inches or less in thickness. The Contractor shall not embed conduit having an outside diameter greater than 1/3 of the thickness of the slab in a concrete slab, nor place conduit below bottom reinforcing steel or over top reinforcing steel. Conduits may be embedded in walls, provided they are not larger in outside diameter than 1/3 the thickness of the wall, are not spaced closer than three diameters on center, and do not impair the strength of the structure. The Contractor

shall support embedded pipes and conduits independently from reinforcing steel in a manner to prevent metallic contact, and thereby, prevent electrolytic deterioration. The Contractor shall place embedded pipes and conduits as nearly as possible to the centerline of the concrete section. The Contractor shall submit all conduit, piping and other wall penetrations, reinforcements and anchor bolt sizing and locations for review and approval.

3.05 REMOVAL OF FORMS

A. Careful procedures for the removal of forms shall be strictly followed, and this Work shall be accomplished with care so as to avoid injury to the concrete. No heavy loading on green, insufficiently cured concrete will be permitted. In the case of roof slabs and above-ground floor slabs, forms for supported slab, but not shoring, shall remain in place until test cylinders for the roof concrete attain a minimum compressive strength of 75 percent of the 28 day strength specified in Section 03300 - Cast-in-Place Concrete; provided, that no forms shall be disturbed or removed under an individual panel or until before the concrete in the adjacent panel or unit has attained 75 percent of the specified 28 day strength and has been in place for a minimum of 7 days. The time required to establish said strength shall be as determined by the Engineer from several test cylinders obtained by the Contractor for this purpose from concrete used in the first group of roof panels placed. If the time so determined is more than the 7-day minimum, then that time shall be used as the minimum length of time. Forms for all vertical walls and columns shall remain in place at least 2 days after the concrete has been placed. Forms for all parts of the Work not specifically mentioned herein shall remain in place for periods of time as determined by the Engineer.

B. The Contractor shall not backfill against walls until the top slab is in place and all concrete has obtained compressive strength equal to the specified 28-day compressive strength.

C. Immediately upon removal of the forms, the concrete surfaces shall be thoroughly wetted and shall be kept wet until the curing compound is applied, or other curing procedure made effective, in accordance with the specification requirements.

D. The Contractor shall assume responsibility for damage resulting from improper and premature removal of forms.

3.06 REUSE OF FORMS

A. Forms may be reused only if in good condition and only if acceptable to the Engineer. Light sanding between uses will be required wherever necessary to obtain uniform surface texture on all exposed concrete surfaces. Exposed concrete surfaces are defined as surfaces which are permanently exposed to view. In the case of forms for the inside wall surfaces of hydraulic/water retaining structures, unused tie rod holes in forms shall be filled with non-shrink grout.

3.07 MAINTENANCE OF FORMS

A. Forms shall be maintained at all times in good condition, particularly as to size, shape, strength, rigidity, tightness, and smoothness of surface. Forms, when in place, shall conform to the established alignment and grades. Before concrete is placed, the forms shall be thoroughly cleaned. The form surfaces shall be treated with a non-staining mineral oil or other lubricant acceptable to the Engineer. Any excess lubricant shall be satisfactorily removed before placing the concrete. Where field oiling of forms is required, the Contractor shall perform the oiling at least 2 weeks in advance of their use.

Care shall be exercised to keep oil off the surfaces of steel reinforcement and other metal items to be embedded in concrete.

3.08 FALSE WORK

A. The Contractor shall be responsible for the design, engineering, construction, maintenance, and safety of all false work, including staging, walkways, forms, ladders, and similar appurtenances, which shall equal or exceed the applicable requirements of the provisions of the OSHA Safety and Health Standards for Construction, and the requirements of the California Division of Industrial Safety.

3.09 REMOVAL OF SHORING AND FALSE WORK

A. The Contractor shall not remove shoring and false work until 21 days after concrete placement, or concrete has attained at least 90 percent of the 28-day design compressive strength as demonstrated by control test cylinders, but not sooner than 14 days. If testing is competed to review the 90 percent compressive strength, the Contractor shall incur the cost.

3.10 LOAD RESTRICTION

A. The Contractor shall not impose construction, equipment or permanent loads on columns, supported slabs, or supported beams until concrete has attained the 28-day design compressive strength.

END OF SECTION

SECTION 03200 - REINFORCEMENT STEEL

PART 1 - GENERAL

1.01 DESCRIPTION

A. The Contractor shall provide concrete reinforcement steel, welded wire fabric, couplers, concrete inserts, wires, clips, supports, chairs, spacers, and other accessories, complete, all in accordance with the Contract Documents.

B. Work Included in this Section: Principal items are:

1. Furnishing and placing bar and mesh reinforcing for cast-in-place concrete.

2. Furnishing reinforcing steel bars for masonry, including delivery to the site.

3. Submittals.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. The Work of the following Sections apply to the Work of this Section. Other Sections, not referenced below, shall also apply to the extent required for proper performance of this Work.

1. Section 03100 - Concrete Formwork

2. Section 03300 - Cast-in-Place Concrete

3. Section 03315 - Grout

4. Section 03400 – Precast Concrete

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Except as otherwise indicated in this Section of the Specifications, the Contractor shall comply with the latest adopted edition of the Standard Specifications for Public Works Construction (SSPWC), together with the latest adopted editions of the Regional Amendments.

B. The current edition of the Uniform Building Code (UBC) of International Conference of Building Officials (ICBO).

C. Commercial Standards (Current Edition):

1.	ACI 315	Details and Detailing of Concrete Reinforcement
2.	ACI 318	Building Code Requirements for Structural Concrete
3.	CRSI MSP	Concrete Reinforcing Steel Institute Manual of Standard Practice
4.	CRSI PRB	Concrete Reinforcing Steel Institute Placing Reinforcing Bars
5.	WRI	Manual of Standard Practice for Welded Wire Fabric

6.	AWS D 1.4	Structural Welding Code - Reinforcing Steel
7.	ACI 117	Standard Tolerance for Concrete Construction Materials

D. ASTM Standards in Building Codes (Current Edition):

1. ASTM A 82: Specification for Steel Wire, Plain, for Concrete Reinforcement

2. ASTM A 185: Specification for Welded Steel Wire Fabric, Plain, for Concrete Reinforcement

3. ASTM A 615: Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement

4. ASTM A 706: Specification for Low-Alloy Steel Deformed Bars for Concrete Reinforcement

5. ASTM A 775: Specification for Epoxy-Coated Reinforcing Steel Bars

E. National Sanitation Foundation

1. NSF / ANSI 61: Drinking Water System Components – Health Effects

1.04 CONTRACTOR SUBMITTALS

A. The Contractor shall furnish shop bending diagrams, placing lists, and drawings of all reinforcement steel before fabrication in accordance with the requirements of the Specification Section 01300 – Contractor Submittals.

B. Details of the concrete reinforcement steel and concrete inserts shall be submitted at the earliest possible date after receipt of the Notice to Proceed. Details of reinforcement steel for fabrication and erection shall conform to ACI 315 and the requirements indicated. The shop bending diagrams shall show the actual lengths of bars, to the nearest inch, measured to the intersection of the extensions (tangents for bars of circular cross-section) of the outside surface. The shop drawings shall include bar placement diagrams which clearly indicate the dimensions of each bar splice.

C. Where mechanical couplers are required or permitted to be used to splice reinforcement steel, the Contractor shall submit manufacturer's literature including instructions and recommendations for installation for each type of coupler used; certified test reports which verify the load capacity of each type and size of coupler used; and shop drawings which show the location of each coupler with details of how they are to be installed in the formwork.

D. If reinforcement steel is spliced by welding at any location, the Contractor shall submit mill test reports which shall include the information necessary for the determination of the carbon equivalent as specified in AWS D 1.4. The Contractor shall submit a written welding procedure for each type of weld for each size of bar which is to be spliced by welding; a mere statement that AWS procedures will be followed will not be acceptable.

1.05 QUALITY ASSURANCE

A. If requested by the Engineer, the Contractor shall furnish samples from each heat of reinforcement steel delivered in a quantity adequate for testing. Costs of initial tests will

be paid by the Contractor. Costs of additional tests due to material failing initial tests shall also be paid by the Contractor.

B. If reinforcement steel is spliced by welding at any location, the Contractor shall submit certifications of procedure qualifications for each welding procedure used and certification of welder qualifications, for each welding procedure, and for each welder performing the Work. Such qualifications shall be as specified in AWS D 1.4.

C. If requested by the Engineer, the Contractor shall furnish samples of each type of welded splice used in the Work in a quantity and of dimensions adequate for testing. At the discretion of the Engineer, radiographic testing of direct butt welded splices will be performed. The Contractor shall provide assistance necessary to facilitate testing. The Contractor shall repair any weld which fails to meet the requirements of AWS D 1.4. The costs of testing will be paid by the Contractor. The costs of all tests which fail to meet specified requirements shall also be paid by the Contractor.

PART 2 - PRODUCTS

2.01 MATERIAL REQUIREMENTS

A. Materials which may remain or leave residues on or within the concrete shall be classified as acceptable for potable water use by the Environmental Protection Agency within 30 days of application or use.

2.02 REINFORCEMENT STEEL

A. Reinforcement steel for all cast-in-place reinforced concrete construction shall conform to the following requirements:

1. Bar reinforcement shall conform to the requirements of ASTM A 615 for Grade 60 Billet Steel Reinforcement or as otherwise indicated.

2. All welded reinforcement, specifically detailed or otherwise indicated, shall be low-alloy Grade 60 deformed bars conforming to the requirements of ASTM A 706.

3. Welded wire fabric reinforcement shall conform to the requirements of ASTM A 185 and the details indicated; provided, that welded wire fabric with longitudinal wire of W4 size wire and smaller shall be either provided in flat sheets or in rolls with a core diameter of not less than 10 inches; and provided further, that welded wire fabric with longitudinal wires larger than W4 size shall be provided in flat sheets only.

4. Spiral reinforcement shall be cold-drawn steel wire conforming to the requirements of ASTM A 82.

5. Tie wire shall be Annealed Steel, 14 gauge minimum.

B. Accessories:

1. Accessories shall include all necessary chairs, slab bolsters, concrete blocks, tie wires, dips, supports, spacers, and other devices to position reinforcement during concrete placement. All bar supports shall meet the requirements of the CRSI Manual of Standard Practice, Chapter 3, including special requirements for supporting epoxy-coated reinforcing bars. Wire bar supports shall be CRSI

Class 1 for maximum protection with a 1/8 inch minimum thickness of plastic coating which extends at least ½ inch from the concrete surface. Plastic shall be gray in color.

2. Concrete blocks (dobies), used to support and position reinforcement steel, shall have the same or higher compressive strength as specified for the concrete in which it is located. Wire ties shall be embedded in concrete block bar supports.

C. Epoxy coating for reinforcing and accessories, where indicated, shall conform to ASTM A 775.

2.03 MECHANICAL COUPLERS

A. Mechanical couplers shall be provided where indicated and where approved by the Engineer. The couplers shall develop a tensile strength which exceeds 125 percent of the yield strength of the reinforcement bars being spliced at each splice.

B. Where the type of coupler used is composed of more than one component, all components required for a complete splice shall be supplied. This shall apply to all mechanical splices, including those splices intended for future connections.

C. The reinforcement steel and coupler used shall be compatible for obtaining the required strength of the connection. Straight threaded type couplers shall require the use of the next larger size reinforcing bar or shall be used with reinforcing bars with specially forged ends which provide upset threads which do not decrease the basic cross-section of the bar.

2.04 WELDED SPLICES

A. Welded splices shall be provided where indicated and where approved by the Engineer. All welded splices of reinforcement steel shall develop a tensile strength which exceeds 125 percent of the yield strength of the reinforcement bars which are connected.

B. Provided materials shall be capable of conforming to the Weld Splice requirements of AWS D 1.4.

2.05 EPOXY GROUT

A. Epoxy for grouting reinforcing bars shall be specifically formulated for such application, for the moisture condition, application temperature, and orientation of the hole to be filled. Epoxy grout shall be in conformance with Section 03315 - Grout.

2.06 MANUFACTURERS

A. Couplers/welded splices shall be manufactured by one of the following or equal:

1. Lenton Form Saver by Erico Products

2. Dowel Bar Splicer System by Richmond Screw Anchor Company

2.07 NSF / ANSI STANDARD 61

A. All cementitious material, admixtures, curing compounds, and other industrial produced materials used in concrete, or for curing or repairing of concrete, that can contact potable water or water that will be treated to become potable shall be listed in NSF / ANSI Standard 61.

PART 3 - EXECUTION

3.01 GENERAL

A. All reinforcement steel, welded wire fabric, couplers, and other appurtenances shall be fabricated, and placed in accordance with the requirements of the Uniform Building Code and the supplementary requirements indicated herein.

3.02 FABRICATION AND DELIVERY

A. The Contractor shall conform to CRSI MSP, Chapters 6 and 7, except as otherwise indicated or specified. The Contractor shall bundle reinforcement and tag with suitable identification to facilitate sorting and placing, and transport and storage at the site so as not to damage material. The Contractor shall keep a sufficient supply of tested, approved, and proper reinforcement at the site to avoid delays.

B. Bending and Forming: The Contractor shall bend bars of indicated size and accurately form in accordance with the requirements of ACI 315 and ACI 318 to shapes and lengths indicated on the Plans and required by methods not injurious to materials. The Contractor shall not heat reinforcement for bending. Bars with kinks or bends not conforming with approved shop drawings will be rejected.

C. Fabricating Tolerance: All fabrication of reinforcing bars shall meet the requirements of ACI 117.

D. Reinforcing Bars for Masonry: The Contractor shall detail and fabricate bars at the shop, ready for installation by masons.

3.03 PLACING

A. Reinforcement steel shall be accurately positioned and shall be supported and wired together to prevent displacement, using annealed iron wire ties or suitable clips at intersections. All reinforcement steel shall be supported by concrete, plastic or metal supports, spacers or metal hangars which are strong and rigid enough to prevent any displacement of the reinforcement steel. Where concrete is to be placed on the ground, supporting concrete blocks (or dobies) shall be used, in sufficient numbers to support the bars without settlement, but in no case shall such support be continuous. All concrete blocks used to support reinforcement steel shall be tied to the steel with wire ties which are embedded in the blocks. For concrete over formwork, the Contractor shall furnish concrete, metal, plastic, or other acceptable bar chairs and spacers.

B. Limitations on the use of bar support materials shall be as follows:

1. Concrete Dobies: Permitted at all locations except where architectural finish is required.

2. Wire Bar Supports: Permitted only at slabs over dry areas, interior dry wall surfaces, and exterior wall surfaces.

3. Plastic Bar Supports: Permitted at all locations except on grade.

C. Tie wires shall be bent away from the forms in order to provide the specified concrete coverage.

D. Bars additional to those shown which may be found necessary or desirable by the Contractor for the purpose of securing reinforcement in position shall be provided by the Contractor at no additional cost to the Owner.

E. Unless otherwise specified, reinforcement placing tolerances shall be within the limits specified in Section 7.5 of ACI 318 except where in conflict with the requirements of the UBC.

F. Bars may be moved as necessary to avoid interference with other reinforcement steel, conduits, or embedded items. If bars are moved more than one bar diameter, or enough to exceed the above tolerances, the resulting arrangement of bars shall be subject to the approval of the Engineer.

G. Welded wire fabric reinforcement placed over horizontal forms shall be supported on slab bolsters. Slab bolsters shall be spaced not more than 30 inches on center, shall extend continuously across the entire width of the reinforcement mat, and shall support the reinforcement mat in the plane indicated.

H. Welded wire fabric placed over the ground shall be supported on wired concrete blocks (dobies) spaced not more than 3 feet on center in any direction. The construction practice of placing welded wire fabric on the ground and hooking into place in the freshly placed concrete shall not be allowed.

I. Epoxy-coated reinforcing bars shall be stored, transported, and placed in such a manner as to avoid chipping of the epoxy coating. Non-abrasive slings made of nylon and similar materials shall be used. Specially coated bar supports shall be used. All chips or cracks in the epoxy coating shall be repaired with a compatible epoxy repair material prior to placing concrete.

J. Accessories supporting reinforcing bars shall be spaced such that there is no deflection of the accessory from the weight of the supported bars. When used to space the reinforcing bars from wall forms, the forms and bars shall be located so that there is no deflection of the accessory when the forms are tightened into position.

3.04 SPLICES

A. Splicing shall be in accordance with ACI 318, unless otherwise noted on the Plans.

B. Vertical Bars: Except as specifically detailed or otherwise indicated, splicing of vertical bars in concrete is not permitted, except at the indicated or approved horizontal construction joints or as otherwise specifically detailed.

C. Horizontal Bars: Except as specifically detailed or otherwise indicated, splicing of horizontal bars in concrete is not permitted.

D. Mechanical Couplers: Unless otherwise indicated or approved by the Engineer, use of mechanical couplers is not permitted.

E. Welding: Except as specifically detailed or otherwise indicated, welding of reinforcing bars is not permitted.

3.05 ADDITIONAL REINFORCING

A. The Contractor shall provide additional reinforcing bars at sleeves and openings as indicated on the Plans.

3.06 WELDED WIRE MESH

A. The Contractor shall install necessary supports and chairs to hold the wire mesh in place during concrete pours. The Contractor shall straighten mesh to lay in a flat plane and bend mesh as shown or required to fit work. The Contractor shall provide laps of no less than one complete mesh, unless otherwise detailed, and shall tie every other wire at laps. Roll mesh is not acceptable.

3.07 EMBEDMENT OF DRILLED REINFORCING STEEL DOWELS

A. Hole Preparation:

1. The hole diameter shall be as recommended by the epoxy manufacturer but shall be no larger than 0.25 inch greater than the diameter of the outer surface of the reinforcing bar deformations.

2. The depth of the hole shall be as recommended by the epoxy manufacturer to fully develop the bar but shall not be less than 12 bar diameters, unless noted otherwise.

3. The hole shall be drilled by methods which do not interfere with the proper bonding of epoxy.

4. Existing reinforcing steel in the vicinity of proposed holes shall be located prior to drilling. The location of holes to be drilled shall be adjusted to avoid drilling through or nicking any existing reinforcing bars.

5. The hole shall be blown clean with clean, dry compressed air to remove all dust and loose particles.

6. Epoxy shall be injected into the hole through a tube placed to the bottom of the hole. The tube shall be withdrawn as epoxy is placed but kept immersed to prevent formation of air pockets. The hole shall be filled to a depth that ensures that excess material will be expelled from the hole during dowel placement.

7. Dowels shall be twisted during insertion into the partially filled hole so as to guarantee full wetting of the bar surface with epoxy. The bar shall be inserted slowly enough to avoid developing air pockets.

3.08 CLEANING AND PROTECTION

A. Reinforcing steel delivered to the jobsite shall be suitably stored off the ground and protected from oils, mud, concrete splatter and all conditions conducive to corrosion until embedded in concrete.

B. The surfaces of all reinforcement steel and other metalwork to be in contact with concrete shall be thoroughly cleaned of all dirt, grease, loose scale and rust, grout, mortar and other foreign substances immediately before the concrete is placed. Where there is delay in depositing concrete, reinforcement shall be reinspected and, if necessary, recleaned.

END OF SECTION

SECTION 03300 - CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.01 DESCRIPTION

A. The Contractor shall provide finished structural concrete, complete, in accordance with the Contract Documents.

B. The following types of concrete are covered in this Section:

1. STRUCTURAL CONCRETE: Normal weight (145 PCF) concrete to be used in all cases except where noted otherwise in the Contract Documents.

2. LEAN CONCRETE: Concrete to be used for thrust blocks, anchor blocks, pipe trench cut-off blocks and cradles, where the preceding items are detailed on the Plans as unreinforced. Concrete to be used as protective cover for dowels intended for future connection.

C. The term "hydraulic structure" used in these Specifications refers to environmental engineering concrete structures for the containment, treatment, or transmission of water, or other fluids.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. The Work of the following Sections applies to the Work of this Section. Other Sections, not referenced below, shall also apply to the extent required for proper performance of this Work.

1. Section 03100 - Concrete Formwork

2. Section 03200 - Reinforcement Steel

3. Section 03290 - Joints in Concrete Structures

4. Section 03315 – Grout

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Except as otherwise indicated in this Section, the Contractor shall comply with the latest adopted edition of the Standard Specifications for Public Works Construction (SSPWC), together with the latest adopted editions of the Regional Amendments.

B. The current edition of the Uniform Building Code (UBC) of International Conference of Buildings Officials (ICBO).

C. National Sanitation Foundation

1. NSF / ANSI 61: Drinking Water System Components – Health Effects

D. Federal Specifications:

1. UU-B-790A(1)(2): Building Paper, Vegetable Fiber (Kraft, Water-Proofed, Water Repellant and Fire Resistant)

E. Commercial Standards:

1. ACI 117: Standard Tolerances for Concrete Construction and Materials

2. ACI 214: Recommended Practice for Evaluation of Strength Test Results of Concrete

3. ACI 301: Specifications for Structural Concrete for Buildings

4. ACI 309: Consolidation of Concrete

5. ACI 315: Details and Detailing of Concrete Reinforcement

6. ACI 318: Building Codes Requirements for Reinforced Concrete

7. ACI 350R: Environmental Engineering Concrete Structures

F. ASTM Standards in Building Codes:

1. ASTM C 31: Practice for Making and Curing Concrete Test Specimens in the Field

2. ASTM C 33: Specification for Concrete Aggregates

3. ASTM C 39: Test Method for Compressive Strength of Cylindrical Concrete Specimens

4. ASTM C 40: Test Method for Organic Impurities in Fine Aggregates for Concrete

5. ASTM C 42: Test Method of Obtaining and Testing Drilled Cores and Sawed Beams of Concrete

6. ASTM C 88: Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate

7. ASTM C 94: Specification for Ready-Mixed Concrete

8. ASTM C 136: Test Method for Sieve Analysis of Fine and Coarse Aggregates

9. ASTM C 138: Test Method for Unit Weight, Yield, and Air Content of Concrete

10. ASTM C 143: Test Method for Slump of Hydraulic Cement Concrete

11. ASTM C 150: Specification for Portland Cement

12. ASTM C 156: Test Method for Water Retention by Concrete Curing Materials

13. ASTM C 157: Test Method for Length Change of Hardened Hydraulic Cement Mortar and Concrete

14. ASTM C 192: Practice for Making and Curing Concrete Test Specimens in the Laboratory

15. ASTM C 231: Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method

16. ASTM C 260: Specification for Air-Entraining Admixtures for Concrete

17. ASTM C 289: Test Method for Potential Reactivity of Aggregates (Chemical Method)

18 ASTM C 309: Specification for Liquid Membrane-Forming Compounds for Curing Concrete

19. ASTM C 494: Specification for Chemical Admixtures for Concrete

20. ASTM C 107: Practice for Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation

21. ASTM D 1751: Specification for Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Non-Extruding and Resilient Bituminous Types)

22. ASTM D 2419: Test Method for Sand Equivalent Value of Soils and Fine Aggregate

23. ASTM E 119: Method for Fire Tests of Building Construction and Materials

1.04 CONTRACTOR SUBMITTALS

A. Mix Designs: Before starting the Work and within 14 days of the Notice to Proceed, the Contractor shall submit to the Engineer, for review, preliminary concrete mix designs which shall illustrate the proportions and gradations of all materials proposed for each class and type of concrete specified herein in accordance with Specification Section 01300 – Contractor Submittals. The mix designs shall be checked and certified to conform to these Specifications by an independent testing laboratory acceptable to the Engineer to be in conformance with these Specifications. All costs related to such checking and testing shall be borne by the Contractor at no cost to the Owner.

B. Delivery Tickets: Where ready-mix concrete is used, the Contractor shall furnish delivery tickets at the time of delivery of each load of concrete. Each ticket shall show the state-certified equipment used for measuring and the total quantities, by weight, of cement, sand, each class of aggregate, admixtures, and the amounts of water in the aggregate added at the batching plant, and the amount of water allowed to be added at the site for the specific design mix. In addition, each ticket shall state the mix number, total yield in cubic yards, and the time of day, to the nearest minute, corresponding to the times when the batch was dispatched, when it left the plant, when it arrived at the site, when unloading began, and when unloading was finished.

C. The Contractor shall provide the following submittals in accordance with ACI 301:

1. Mill tests for cement.

2. Admixture certification. Chloride ion content must be included.

3. Aggregate gradation and certification.

4. Materials and methods for curing.

D. The Contractor shall provide catalog cuts and other manufacturer's technical data demonstrating compliance with the requirements indicated and specified herein for all admixtures used in the concrete mix design.

1.05 QUALITY ASSURANCE

A. GENERAL

1. Tests on component materials and for compressive strength and shrinkage of concrete will be performed as specified herein. Test for determining slump will be in accordance with the requirements of ASTM C 143.

2. The cost of all laboratory tests requested by the Engineer for cement, aggregates, and concrete, will be borne by the Contractor. The laboratory must meet or exceed the requirements of ASTM C 1077.

3. Concrete for testing shall be supplied by the Contractor at no cost to the Owner and the Contractor shall provide assistance to the independent testing laboratory acceptable to the Engineer in obtaining samples, and disposal and clean up of excess material.

4. A minimum of one (1) set of concrete cylinders and a slump test shall be obtained for every major concrete placement. A minimum of one (1) set of concrete cylinders shall be obtained for all concrete structures, foundations and slabs. One (1) set of cylinders shall be obtained for every forty (40) yards of concrete placed for a particular pour. For instance, if the walls of a structure require eighty (80) yards of concrete; then two (2) sets of concrete cylinders shall be required. If concrete cylinders for compression testing and a slump test are not required, then the delivery tickets accompanying the concrete vendor's truck shall be forwarded to the Construction Manager.

B. Field Compression Tests:

1. Compression test specimens will be taken during construction from the first placement of each class of concrete specified herein and at intervals thereafter as selected by the Engineer to ensure continued compliance with these Specifications. Each set of test specimens will consist of four (4) cylinders.

2. Compression test specimens for concrete shall be made in accordance with Section 9.2 of ASTM C 31. Specimens shall be 6-inch diameter by 12-inch high cylinders.

3. Compression tests shall be performed in accordance with ASTM C 39. One (1) test cylinder will be tested at 7 days and two (2) at 28 days. The remaining cylinder will be held to verify test results, if needed.

C. Evaluation and Acceptance of Concrete:

1. Evaluation and acceptance of the compressive strength of concrete shall be according to the requirements of ACI 318, Chapter 5, "Concrete Quality", and as specified herein.

2. A statistical analysis of compression test results will be performed according to the requirements of ACI 214. The standard deviation of the test results shall not

exceed 640 PSI, when ordered at equivalent water content as estimated by slump.

3. If any concrete fails to meet these requirements, immediate corrective action shall be taken to increase the compressive strength for all subsequent batches of the type of concrete affected.

4. When the standard deviation of the test results exceeds 640 PSI, the average strength for which the mix is designed shall be increased by an amount necessary to satisfy the statistical requirement that the probability of any test being more than 500 PSI below or the average of any three (3) consecutive tests being below the specified compressive strength is 1 in 100. The required average strength shall be calculated by Criterion No. 3 of ACI 214 using the actual standard deviation.

5. All concrete which fails to meet the ACI requirements and these Specifications is subject to removal and replacement at no cost to the Owner.

D. Construction Tolerances: Set and maintain concrete forms and perform finishing operations so as to ensure that the completed Work is within the tolerances specified herein. Surface defects and irregularities are defined as finishes and are to be distinguished from tolerances. Tolerance is the specified permissible variation from lines, grades, or dimensions shown. Where tolerances are not stated in the Specifications, permissible deviations will be in accordance with ACI 117.

1. The following construction tolerances are hereby established and apply to finished walls and slab unless otherwise illustrated:

Item	Tolerance
Variation of the constructed linear outline from the established position in plan.	In 10 feet: ¼ inch In 20 feet or more: ½ inch
Variation from the level or from the grades shown.	In 10 feet: ¼ inch In 20 feet or more: ½ inch
Variation from the plumb.	In 10 feet: ¼ inch In 20 feet or more: ½ inch
Variation in the thickness of slabs and walls.	Minus ¼ inch; Plus ½ inch
Variation in the locations and sizes of slabs and wall openings.	Plus or minus ¼ inch

E. Floor Slab Surface Hardener:

1. Job Mockup: In a location designated by the Engineer, place a minimum 100 square feet floor mockup using materials and procedures proposed for use in the Project. Revise materials and procedures as necessary to obtain acceptable finish surface. Maintain the same controls and procedures used in the acceptable mockup throughout the Project.

2. Field Service: During job mockup and initial period of installation, the manufacturer of the surface hardener shall furnish the service of a trained, full-time representative to advise on proper use of the product. Notify surface hardener manufacturer at least three (3) days before initial use of the product.

3. Installer Qualifications: Installer shall have a minimum of three (3) years experience and shall be specialized in the application of dry shake surface hardeners.

PART 2 - PRODUCTS

2.01 CONCRETE MATERIALS

A. General:

1. All materials specified herein shall be classified by the Environmental Protection Agency as acceptable for potable water use within 30 days of application.

2. Materials shall be delivered, stored, and handled so as to prevent damage by water or breakage. Only one (1) brand of cement shall be used. Cement reclaimed from cleaning bags or leaking containers shall not be used. All cement shall be used in the sequence of receipt of shipments.

B. All materials furnished for the Work shall comply with the requirements of Sections 201, 203, and 204 of ACI 301, as applicable.

C. Storage of materials shall conform to the requirements of Section 2.5 of ACI 301 or the SSPWC.

D. Materials for concrete shall conform to the following requirements:

1. Cement shall be standard brand Portland Cement conforming to ASTM C 150 for Type V. A minimum of 85 percent of cement by weight shall pass a 325 screen. A single brand of cement shall be used throughout the Work, and before its use, the brand shall be acceptable to the Engineer. The cement shall be suitably protected from exposure to moisture until used. Cement that has become lumpy shall not be used. Sacked cement shall be stored in such a manner so as to permit access for inspection and sampling. Certified mill test reports, including fineness, for each shipment of cement to be used shall be submitted to the Engineer if requested regarding compliance with these Specifications.

2. Water for mixing and curing shall be potable, clean, and free from objectionable quantities of silty organic matter, alkali, salts and other impurities. The water shall be considered potable, for the purposes of this Section, only if it meets the requirements of the local governmental agencies. Agricultural water with high total dissolved solids concentration (over 1,000 mg/l) shall not be used.

3. Aggregates shall be obtained from pits acceptable to the Engineer, shall be nonreactive, and shall conform to ASTM C 33. Maximum size of coarse aggregate shall be as specified herein. Lightweight sand for fine aggregate will not be permitted.

a) Coarse aggregates shall consist of clean, hard, durable gravel, crushed gravel, crushed rock or a combination thereof. The coarse aggregates shall be prepared and handled in two or more size groups for combined aggregates with a maximum size greater than ¾ inch. When the aggregates are proportioned for each batch of concrete the two size

groups shall be combined. See the Paragraph in Part 2 entitled "Trial Batch and Laboratory Tests" for the use of the size groups.

b) Fine aggregates shall be natural sand or a combination of natural and manufactured sand that are hard and durable. When tested in accordance with ASTM D 2419, the sand equivalency shall not be less than 75 percent for an average of three samples, nor less than 70 percent for an individual test. Gradation of fine aggregate shall conform to ASTM C 33, with 15 to 30 percent passing the number 50 screen and 5 to 10 percent passing the number 100 screen. The fineness modulus of sand used shall not be over 3.00.

c) Combined aggregates shall be well graded from coarse to fine sizes, and shall be uniformly graded between screen sizes to produce a concrete that has optimum workability and consolidation characteristics. Where a trial batch is required for a mix design, the final combined aggregate gradations will be established during the trial batch process.

d) When tested in accordance with ASTM C 33, the ratio of silica released to reduction in alkalinity shall not exceed 1.0.

e) When tested in accordance with ASTM C 33, the fine aggregate shall produce a color in the supernatant liquid no darker than the reference standard color solution.

f) When tested in accordance with ASTM C 33, the coarse aggregate shall show a loss not exceeding 42 percent after 500 revolutions, or 10.5 percent after 100 revolutions.

g) When tested in accordance with ASTM C 33, the loss resulting after five cycles shall not exceed 10 percent for fine or coarse aggregate when using sodium sulfate.

4. Ready-mix concrete shall conform to the requirements of ASTM C 94.

5. Admixtures: All admixtures shall be compatible and by a single manufacturer capable of providing qualified field service representation. Admixtures shall be used in accordance with manufacturer's recommendations. If the use of an admixture is producing an inferior end result, discontinue use of the admixture. Admixtures shall not contain thiocyanates nor more than 0.05 percent chloride ion, and shall be nontoxic after 30 days.

a) Set controlling and water reducing admixtures: Admixtures may be added at the Contractor's option to control the set, affect water reduction, and increase workability. The addition of an admixture shall be at no increase in cost to the Owner. The use of an admixture shall be subject to acceptance by the Engineer. Concrete containing an admixture shall be first placed at a location determined by the Engineer. Admixtures specified herein shall conform to the requirements of ASTM C 494. The required quantity of cement shall be used in the mix regardless of whether or not an admixture is used.

1) Concrete shall not contain more than one water-reducing admixture. Concrete containing an admixture shall be first placed at a location determined by the Engineer.

2) Set controlling admixture shall be either with or without water-reducing properties. Where the air temperature at the time of placement is expected to be consistently over 80°*F*, a set retarding admixture such as Plastocrete by Sika Corporation; Pozzolith 300R by Master Builders; Daratard by W. R. Grace; or equal shall be used. Where the air temperature at the time of placement is expected to be consistently under 40°*F*, a noncorrosive set accelerating admixture such as Plastocrete 161FL by Sika Corporation; Pozzutec 20 by Master Builders; Daraset by W. R. Grace; or equal shall be used.

3) Normal range water reducer shall conform to ASTM C 494, Type A, WRDA 79 by W. R. Grace; Pozzolith 322-N by Master Builders; Plastocrete 161 by Sika Corporation; or equal. The quality of admixture used and the method of mixing shall be in accordance with the manufacturer's instructions and recommendations.

4) High range water reducer shall conform to ASTM C 494, Type F or G. Daracem 100 or WDRA 19 by W. R. Grace; Sikament FF or Sikament 86 by Sika Corporation; Rheobuild 1000 or Rheobuild 716 by Master Builders; or equal. High range water reducer shall be added to the concrete after all other ingredients have been mixed and initial slump has been verified. No more than 14 ounces of water reducer per sack of cement shall be used. Water reducer shall be considered as part of the mixing water when calculating water cement ratio.

5) If the high range water reducer is added to the concrete at the job site, it may be used in conjunction with the same water reducer added at the batch plant. Concrete shall have a slump of 3 inches + ½ inch before adding the high range water reducing admixture at the job site. The high range water-reducing admixture shall be accurately measured and pressure injected into the mixer as a single dose by an experienced technician. A standby system shall be provided and tested before each day's operation of the job site system.

6) Concrete shall be mixed at mixing speed for a minimum of 30 mixer revolutions after the addition of the high range water reducer.

7) Flyash: Flyash shall not be used.

2.02 CURING MATERIALS

A. Materials for curing concrete as specified herein shall conform to the following requirements and ASTM C 309:

1. All curing compounds shall be white pigmented and resin based. Sodium silicate compounds shall not be allowed. Concrete curing compound shall be Spartan Cote Cure-Seal Hardener by the Burke Company; Super Rez Seal by Euclid Chemical Company; MB-429 as manufactured by Master Builders; or equal. Water-based resin curing compounds shall be used only where local air

quality regulations prohibit the use of a solvent-based compound. Water-based curing compounds shall be Aqua Resincure by the Burke Company; Aqua-Cure by Euclid Chemical Company; Masterkure-W by Master Builders; or equal.

2. Polyethylene sheet for use as a concrete curing blanket shall be white, and shall have a nominal thickness of 6 mils. The loss of moisture when determined in accordance with the requirements of ASTM C 156 shall not exceed 0.055 grams per square centimeter of surface.

3. Polyethylene-coated water proof paper sheeting for use as concrete curing blanket shall consist of white polyethylene sheeting free of visible defects, uniform in appearance, having a nominal thickness of 2 mils and permanently bonded to waterproof paper conforming to the requirements of Federal Specification UU-B-790A(1)(2). The loss of moisture, when determined in accordance with the requirements of ASTM C156, shall not exceed 0.055 gram per square centimeter of surface.

4. Polyethylene-coated burlap for use as concrete curing blanket shall be 4 mils thick, white opaque polyethylene film impregnated or extruded into one side of the burlap. Burlap shall weigh not less than 9 ounces per square yard. The loss of moisture, when determined in accordance with the requirements of ASTM C 156, shall not exceed 0.055 gram per square centimeter of surface.

5. Curing mats for use in Curing Method 6 as specified herein, shall be heavy shag rugs or carpets or cotton mats quilted at 4 inches on center. Curing mats shall weigh a minimum of 12 ounces per square yard when dry.

6. Evaporation retardant shall be a material such as Confilm as manufactured by Master Builders; Eucobar as manufactured by Euclid Chemical Company; or equal.

2.03 NONWATERSTOP JOINT MATERIALS

A. Materials for nonwaterstop joints in concrete shall conform to the following requirements:

1. Preformed joint filler shall be a nonextruding, resilient, bituminous type conforming to the requirements of ASTM D 1751.

2. Mastic joint sealer shall be a material that does not contain evaporating solvents; that will tenaciously adhere to concrete surfaces; that will remain permanently resilient and pliable; that will not be affected by continuous presence of water and will not in any way contaminate potable water; and that will effectively seal the joints against moisture infiltration even when the joints are subject to movement due to expansion and contraction. The sealer shall be composed of special asphalts or similar materials blended with lubricating and plasticizing agents to form a tough, durable mastic substance containing no volatile oils or lubricants and shall be capable of meeting the test requirements set forth hereinafter, if testing is required by the Engineer.

2.04 MISCELLANEOUS MATERIALS

A. Damp-proofing agent shall be an asphalt emulsion, such as Hydrocide 600 by Sonneborn; Damp-proofing Asphalt Coating by Euclid Chemical Company; Sealmastic by W. R. Meadows Inc., or equal.

B. Bonding agents shall be epoxy adhesives conforming to the following products for the applications specified:

1. For bonding freshly-mixed, plastic concrete to hardened concrete, Sikadur 32 Hi-Mod Epoxy Adhesive, as manufactured by Sika Corporation; Concresive Liquid (LPL), as manufactured by Master Builders; BurkEpoxy MV as manufactured by The Burke Company; or equal.

2. For bonding hardened concrete or masonry to steel, Sikadur 31 Hi-Mod Gel as manufactured by Sika Corporation; BurkEpoxy NS as manufactured by The Burke Company; Concresive Paste (LPL) as manufactured by Master Builders; or equal

2.05 CONCRETE DESIGN REQUIREMENTS

A. Mix Design:

1. General: Concrete shall be composed of cement, admixtures, aggregates and water. These materials shall be of the qualities specified. The exact proportions in which these materials are to be used for different parts of the Work will be determined during the trial batch. In general, the mix shall be designed to produce a concrete capable of being deposited so as to obtain maximum density and minimum shrinkage and, where deposited in forms, to have good consolidation properties and maximum smoothness of surface. In mix designs, the percentage of sand of the total weight of fine and coarse aggregate shall not exceed 41 for hydraulic structures or 50 for all other structures, unless noted otherwise. The aggregate gradations shall be formulated to provide fresh concrete that will not promote rock pockets around reinforcing steel or embedded items. The proportions shall be changed whenever necessary or desirable to meet the required results at no additional cost to the Owner. All changes shall be subject to review by the Engineer.

2. Water-Cement Ratio and Compressive Strength: The minimum compressive strength and cement content of concrete shall be not less than that specified in the following table:

Type of Work	Min. 28-Day Compressive Strength (PSI)	Max Size Aggregate (in)	Minimum Cement Per CU YD (lb)	Minimum Fibermesh Per CU YD (lb)	Max W/C Ratio (by weight)
Structural Concrete:	5,000	3/4	658	1.5	0.45
Normal weight reinforced concrete (145 pcf)	5,000	3/4	658	1.5	0.45
Lean Concrete	4,500	3/4	611	1.5	0.45

NOTE: The Contractor is cautioned that the limiting parameters specified above are not a mix design. Additional cement or water-reducing agent may be required to achieve workability demanded by the Contractor's construction methods and aggregates. The Contractor is responsible for any costs associated with furnishing concrete with the required workability.

3. Adjustments to Mix Design: The mixes used shall be changed whenever such chance is necessary or desirable to secure the required strength, density, workability, and surface finish and the Contractor shall be entitled to no additional compensation because of such changes.

B. Consistency:

1. The quantity of water entering into a batch of concrete shall be just sufficient, with a normal mixing period, to produce a concrete which can be worked properly into place without segregation, and which can be compacted by the vibratory methods herein specified to give the desired density, impermeability and smoothness of surface. The quantity of water shall be changed as necessary, with variations in the nature or moisture content of the aggregates, to maintain uniform production of a desired consistency. The consistency of the concrete in successive batches shall be determined by slump tests in accordance with ASTM C 143. The slumps shall be as follows:

Part of Work	Slump (in)
All concrete, unless noted otherwise	4 inches + 1/2-inch
With high range water reducer added	5 inches + 1/2-inch

C. Trial Batch and Laboratory Tests:

1. Before placing any concrete, a testing laboratory approved by the Engineer will prepare a trial batch of each class of structural concrete, based on the preliminary concrete mixes submitted by the Contractor. During the trial batch the aggregate proportions may be adjusted by the testing laboratory using the two coarse aggregate size ranges to obtain the required properties. If one size range produces an acceptable mix, a second size range need not be used. Such adjustments shall be considered refinements to the mix design and shall not be the basis for extra compensation to the Contractor. All concrete shall conform to the requirements of this Section, whether the aggregate proportions are from the Contractor's preliminary mix design, or whether the proportions have been adjusted during the trial batch process. The trial batch will be prepared using the aggregates, cement and admixture proposed for the project. The trial batch materials shall be of a quantity such that the testing laboratory can obtain 3 drying shrinkage, and six compression test specimens from each batch. The cost of not more than three laboratory trial batch tests for each specified concrete strength will be borne by the Contractor. The Contractor shall furnish and deliver the materials in steel drums to the approved testing laboratory. Any additional trial batch testing required shall be performed by the testing laboratory at no additional cost to the Owner.

2. The determination of compressive strength will be made by testing 6-inch diameter by 12 inch high cylinders; made, cured and tested in accordance with ASTM C 192 and ASTM C 39. Three compression test cylinders will be tested at 7 days and 3 at 28 days. The average compressive strength for the three cylinders tested at 28 days for any given trial batch shall not be less than 125 percent of the specified compressive strength.

3. A sieve analysis of the combined aggregate for each trial batch shall be performed according to the requirements of ASTM C 136. Values shall be given for percent passing each sieve.

4. In lieu of trial batch and laboratory tests specified in this Section, the Contractor may submit previously-designed, tested, and successfully-used concrete mixes, using materials similar to those intended for this project, together with a minimum of three certified test reports of the 28 day strength of the proposed concrete mix.

D. Shrinkage Limitation:

1. The maximum concrete shrinkage for specimens cast in the laboratory from the trial batch, as measured at 21 day drying age or at 28 day drying age shall be 0.036 percent or 0.042 percent, respectively. Use a mix design for construction that has first met the trial batch shrinkage requirements. Shrinkage limitations apply only to structural concrete.

2. The maximum concrete shrinkage for specimens cast in the field shall not exceed the trial batch maximum shrinkage requirement by more than 25 percent.

3. If the required shrinkage limitation is not met during construction, take any or all of the following actions, at no additional cost to the Owner for securing the specified shrinkage requirements. These actions may include changing the source of aggregates, cement and/or admixtures; reducing water content; washing of aggregate to reduce fines; increasing the number of construction joints, modifying the curing requirements; or other actions designed to minimize shrinkage or the effects of shrinkage.

E. Measurement of Cement and Aggregate:

1. The amount of cement and of each separate size of aggregate entering into each batch of concrete shall be determined by direct weighing equipment acceptable to the Engineer.

2. Weighing Tolerances:

Material	Percent of Total Weight
Cement	1
Aggregates	3
Admixtures	3

F. Measurement of Water:

1. The quantity of water entering the mixer shall be measured by a suitable water meter or other measuring device of a type acceptable to the Engineer and capable of measuring the water in variable amounts within a tolerance of one percent. The water feed control mechanism shall be capable of being locked in position so as to deliver constantly any specified amount of water to each batch of concrete. A positive quick-acting valve shall be used for a cut-off in the water line to the mixer. The operating mechanism must be such that leakage will not occur when the valves are closed.

2.06 READY-MIXED CONCRETE

A. At the Contractor's option, ready-mixed concrete may be used meeting the requirements as to materials, batching, mixing, transporting, and placing as specified herein and in accordance with ASTM C 94, including the following supplementary requirements.

B. Ready-mixed concrete shall be delivered to the site of the Work, and discharge shall be completed within one and one-half hour (90 minutes) after the addition of the cement to the aggregates or before the drum has been revolved 250 revolutions, whichever is first.

C. Truck mixers shall be equipped with electrically-actuated counters by which the number of revolutions of the drum or blades may be readily verified. The counter shall be of the resettable, recording type, and shall be mounted in the driver's cab. The counters shall be actuated at the time of starting mixers at mixing speeds.

D. Each batch of concrete shall be mixed in a truck mixer for not less than 70 revolutions of the drum or blades at the rate of rotation designated by the manufacturer of equipment. Additional mixing, if any, shall be at the speed designated by the manufacturer of the equipment as agitating speed. All materials including mixing water shall be in the mixer drum before actuating the revolution counter for determining the number of revolution of mixing.

E. Truck mixers and their operation shall be such that the concrete throughout the mixed batch as discharged is within acceptable limits of uniformity with respect to consistency, mix, and grading. If slump tests taken at approximately the one-quarter (1/4) and three-quarter (3/4) points of the load during discharge give slumps differing by more than one inch (1") when the specified slump is 3 inches or less, or if they differ by more than 2 inches when the specified slump is more than 3 inches, the mixer shall not be used on the Work unless the causing condition is corrected and satisfactory performance is verified by additional slump tests. All mechanical details of the mixer, such as water measuring and discharge apparatus, condition of the blades, speed of rotation, general mechanical condition of the unit, and clearance of the drum, shall be checked before a further attempt to use the unit will be permitted.

F. Each batch of ready-mixed concrete delivered at the job site shall be accompanied by a delivery ticket furnished to the Engineer in accordance with Subsection 03300-1.04B.

G. The use of nonagitating equipment for transporting ready-mixed concrete will not be permitted. Combination truck and trailer equipment for transporting ready-mixed concrete will not be permitted. The quality and quantity of materials used in ready-mixed concrete and in batch aggregates shall be subject to continuous inspection at the batching plant by the Engineer.

2.07 FLOOR HARDENER (SURFACE APPLIED)

A. Surface hardener shall be a light reflective nonoxidizing metallic aggregate dry shake surface hardener.

1. Surface hardener shall be premeasured, premixed and packaged at the factory.

2. Apply surface hardener at the rate of 1.8 to 2.5 lb per square foot.

3. Surface hardener shall be Alumiplate@, by Master Builders, Inc., or equal.

B. Curing Compound shall meet the moisture retention requirements of ASTM C 309 and surface hardener manufacturer's recommendations.

C. Monomolecular Film: Evaporation retarder shall be used to aid in maintaining concrete moisture during the early placement stages of plastic concrete. Evaporation retarder shall be as recommended by surface hardener manufacturer.

2.08 NSF / ANSI STANDARD 61

A. All cementitious material, admixtures, curing compounds, and other industrial produced materials used in concrete, or for curing or repairing of concrete, that can contact potable water or water that will be treated to become potable shall be listed in NSF / ANSI Standard 61.

PART 3 - EXECUTION

3.01 PROPORTIONING AND MIXING

A. Proportioning: Proportioning of the concrete mix shall conform to the requirements of Chapter 3, "Proportioning" of ACI 301.

B. Mixing: Mixing of concrete shall conform to the requirements of Chapter 7 of said ACI 301 Specifications.

C. Slump: Maximum slumps shall be as specified herein.

D. Retempering: Retempering of concrete or mortar which has partially hardened shall not be permitted.

3.02 PREPARATION OF SURFACES FOR CONCRETING

A. General: Earth surfaces shall be thoroughly wetted by sprinkling, before the placing of any concrete, and these surfaces shall be kept moist by frequent sprinkling up to the time of placing concrete thereon. The surface shall be free from standing water, mud, and debris at the time of placing concrete.

B. Joints in Concrete: Concrete surfaces upon or against which concrete is to be placed, where the placement of the concrete has been stopped or interrupted so that, as determined by the Engineer, the new concrete cannot be incorporated integrally with that previously placed, are defined as construction joints. The surfaces of horizontal joints shall be given a compacted, roughened surface for good bond. The joint surfaces shall be cleaned of all laitance, loose or defective concrete, foreign material, and roughened to a minimum of ¼ inch amplitude. Such cleaning and roughening shall be accomplished by hydroblasting or sandblasting (exposing aggregate) followed by thorough washing. All pools of water shall be removed from the surface of construction joints, and the joint surface shall be coated with an epoxy-bonding agent, unless indicated otherwise, before the new concrete is placed.

C. Placing Interruptions: When placing of concrete is to be interrupted long enough for the concrete to take a set, the working face shall be given a shape by the use of forms or other means, that will secure proper union with subsequent Work; provided that construction joints shall be made only where acceptable to the Engineer.

D. Embedded Items: No concrete shall be placed until all formwork, installation of parts to be embedded, reinforcement steel, and preparation of surfaces involved in the placing have been completed and accepted by the Engineer at least 4 hours before placement of concrete. All surfaces of forms and embedded items that have become encrusted with

dried grout from concrete previously placed shall be cleaned of all such grout before the surrounding or adjacent concrete is placed.

E. All inserts or other embedded items shall conform to the requirements herein.

F. All reinforcement, anchor bolts, sleeves, inserts, and similar items shall be set and secured in the forms where illustrated on the Plans or by approved shop drawings and shall be acceptable to the Engineer before any concrete is placed. Accuracy of placement is the responsibility of the Contractor.

G. Casting New Concrete Against Old: Where concrete is to be cast against old concrete (any concrete which is greater than 60 days of age), the surface of the old concrete shall be thoroughly cleaned and roughened by hydroblasting or sandblasting (exposing aggregate). The joint surface shall be coated with an epoxy bonding agent unless indicated otherwise by the Engineer.

H. No concrete shall be placed in any structure until all water entering the space to be filled with concrete has been properly cut off or has been diverted by pipes, or other means, and carried out of the forms, clear of the Work. No concrete shall be deposited underwater nor shall the Contractor allow still water to rise on any concrete until the concrete has attained its initial set. Water shall not be permitted to flow over the surface of any concrete in such manner and at such velocity as will injure the surface finish of the concrete. Pumping or other necessary dewatering operations for removing ground water, if required, will be subject to the review of the Engineer.

I. Corrosion Protection: Pipe, conduit, dowels, and other ferrous items required to be embedded in concrete construction shall be so positioned and supported before placement of concrete that there will be a minimum of 2 inches clearance between said items and any part of the concrete reinforcement. Securing such items in position by wiring or welding them to the reinforcement will not be permitted.

J. Openings for pipes, inserts for pipe hangars and brackets, and the setting of anchors shall, where practicable, be provided for during the placing of concrete.

K. Anchor bolts shall be accurately set, and shall be maintained in position by templates while embedded in concrete.

L. Cleaning: The surfaces of all metalwork to be in contact with concrete shall be thoroughly cleaned of all dirt, grease, loose scale and rust, grout, mortar, and other foreign substances immediately before the concrete is placed.

3.03 HANDLING, TRANSPORTING AND PLACING

A. General: Placing of concrete shall conform to the applicable requirements of Chapter 8 of ACI 301 and the requirements of this Section. No aluminum materials shall be used in conveying any concrete.

B. Nonconforming Work or Materials: Concrete which upon or before placing is found not to conform to the requirements specified herein shall be rejected and immediately removed from the Work. Concrete which is not placed in accordance with these Specifications, or which is of inferior quality, shall be removed and replaced at no additional expense to the Owner.

C. Unauthorized Placement: No concrete shall be placed except in the presence of duly authorized representative of the Engineer. The Contractor shall notify the Engineer in writing at least 48 hours in advance of placement of any concrete.

D. Placement in Wall Forms: Concrete shall not be dropped through reinforcement steel or into any deep form, nor shall concrete be placed in any form in such a manner as to leave accumulation of mortar on the form surfaces above the placed concrete. In such cases, some means such as the use of hoppers and, if necessary, vertical ducts of canvas, rubber, or metal shall be used for placing concrete in the forms in a manner that it may reach the place of final deposit without separation. In no case shall the free fall of concrete exceed 4 feet below the ends of ducts, chutes, or buggies. Concrete shall be uniformly distributed during the process of depositing and in no case after depositing shall any portion be displaced in the forms more than 6 feet in horizontal direction. Concrete in forms shall be deposited in uniform horizontal layers not deeper than 2 feet; and care shall be taken to avoid inclined layers or inclined construction joints except where such are required for sloping members. Each layer shall be placed while the previous layer is still soft. The rate of placing concrete in forms shall not exceed 5 feet of vertical rise per hour. Sufficient illumination shall be provided in the interior of all forms so that the concrete at the places of deposit is visible from the deck or runway.

E. Conveyor Belts and Chutes: All ends of chutes, hopper gates, and all other points of concrete discharge throughout the Contractor's conveying, hoisting and placing system shall be so designed and arranged that concrete passing from them will not fall separated into whatever receptacle immediately receives it. Conveyor belts, if used, shall be of a type acceptable to the Engineer. Chutes longer than 50 feet will not be permitted. Minimum slopes of chutes shall be such that concrete of the specified consistency will readily flow in them. If a conveyor belt is used, it shall be wiped clean by a device operated in such a manner that none of the mortar adhering to the belt will be wasted. All conveyor belts and chutes shall be covered.

F. Placement in Slabs: Concrete placed in sloping slabs shall proceed uniformly from the bottom of the slap to the top, for the full width of the placement. As the Work progresses, the concrete shall be vibrated and carefully worked around the slab reinforcement, and the surface of the slab shall be screeded in an up-slope direction.

G. Temperature of Concrete: The temperature of concrete when it is being placed shall be not more than 90°*F* nor less than 55°*F* for sections less than 12 inches thick nor less than 50°*F* for all other sections. Concrete ingredients shall not be heated to a temperature higher than that necessary to keep the temperature of the mixed concrete, as placed, from falling below the specified minimum temperature. When the temperature of the concrete is 85°*F* or above, the time between the introduction of the cement to the aggregates and discharge at the Site shall not exceed 45 minutes. If concrete is placed when the weather is such that the temperature of the concrete would exceed 90°*F*, the Contractor shall employ effective means, such as precooling of aggregates and mixing water using ice or placing at night, as necessary to maintain the temperature of the concrete, as it is placed, below 90°*F*. The Contractor shall be entitled to no additional compensation on account of the foregoing requirements.

H. Cold Weather Placement:

1. Placement of concrete shall conform to ACI 306.1 - Standard Specification for Cold Weather Concreting, and the following.

2. Remove all snow, ice and frost from the surfaces, including reinforcement, against which concrete is to be placed. Before beginning concrete placement, thaw the subgrade to a minimum depth of 6 inches. All reinforcement and embedded items shall be warmed to above 32°*F* before concrete placement.

3. Maintain the concrete temperature above 50°*F* for at least 3 days after placement.

I. Hot Weather Placement:

1. Placement of concrete shall conform to ACI 305R - Hot Weather Concreting, and the following.

2. Only set retarding admixture shall be used in concrete when air temperature is expected to be consistently over 80°*F*.

3. The maximum temperature of concrete shall not exceed 90°*F* immediately before placement.

4. From the initial placement to the curing state, concrete shall be protected from the adverse effect of high temperature, low humidity, and wind.

3.04 PUMPING OF CONCRETE

A. General: If the pumped concrete does not produce satisfactory end results, discontinue the pumping operation and proceed with the placing of concrete using conventional methods.

B. Pumping Equipment: The pumping equipment must have two (2) cylinders and be designed to operate with one (1) cylinder only in case the other one is not functioning. In lieu of this requirement, the Contractor shall maintain a standby pump on the site during pumping.

C. The minimum diameter of the hose (conduits) shall be in accordance with ACI 304.2R.

D. Pumping equipment and hoses (conduits) that are not functioning properly, shall be replaced.

E. Aluminum conduits for conveying the concrete shall not be permitted.

F. Field Control: Concrete samples for slump, air content, and test cylinders will be taken at the placement (discharge) end of the line.

3.05 ORDER OF PLACING CONCRETE

A. The order of placing concrete in all parts of the Work shall be acceptable to the Engineer. In order to minimize the effects of shrinkage, the concrete shall be placed in units as bounded by construction joints. The placing of units shall be accomplished by placing alternate units in a manner such that each unit placed shall have cured at least 7 days for hydraulic structures and 3 days for all other structures before the contiguous unit or units are placed, except that the corner sections of vertical walls shall not be placed until the two (2) adjacent wall panels have cured at least 14 days for hydraulic structures and 7 days for all other structures.

B. The surface of the concrete shall be level whenever a run of concrete is stopped. To ensure a level, straight joint on the exposed surface of walls, a wood strip at least ¾ inch thick shall be tacked to the forms on these surfaces. The concrete shall be carried about ½ inch above the underside of the strip. About one (1) hour after the concrete is placed, the strip shall be removed and any irregularities in the edge formed by the strip shall be leveled with a trowel and all laitance shall be removed.

3.06 TAMPING AND VIBRATING

A. As concrete is placed in the forms or in excavations, it shall be thoroughly settled and compacted, throughout the entire depth of the layer which is being consolidated, into a dense, homogeneous mass, filling all corners and angles, thoroughly embedding the reinforcement, eliminating rock pockets, and bringing only a slight excess of water to the exposed surface of concrete during placement. Vibrators shall be Group 3 (per ACI 309) high speed power vibrators (8,000 to 12,000 rpm) of an immersion type in sufficient number and with (at least one) standby units as required. Group 2 vibrators may be used only at specific locations when accepted by the Engineer.

B. Care shall be exercised in placing concrete around waterstops. The concrete shall be carefully worked by rodding and vibrating to make sure that all air and rock pockets have been eliminated. Where flat-strip type waterstops are placed horizontally, the concrete shall be worked under the waterstops by hand, making sure that all air and rock pockets have been eliminated. Concrete surrounding the waterstops shall be given additional vibration, over and above that used for adjacent concrete placement to assure complete embedment of the waterstops in the concrete.

C. Concrete in walls shall be internally vibrated and at the same time rammed, stirred, or worked with suitable appliances, tamping bars, shovels, or forked tools until it completely fills the forms or excavations and closes snugly against all surfaces. Subsequent layers of concrete shall not be placed until the layers previously placed have been worked thoroughly as specified. Vibrators shall be provided in sufficient numbers, with standby units as required, to accomplish the results herein specified within 15 minutes after concrete of the prescribed consistency is placed in the forms. The vibrating head shall be kept from contact with the surfaces of the forms. Care shall be taken not to vibrate concrete excessively or to work it in any manner that causes segregation of its constituents.

3.07 FINISHING CONCRETE SURFACES

A. General: Surfaces shall be free from fins, bulges, ridges, offsets, honeycombing, or roughness of any kind, and shall present a finished, smooth, continuous hard surface. Allowable deviations from plumb or level and from the alignment, profiles, and dimensions shown are defined as tolerances and are specified in Part 1, herein. These tolerances are to be distinguished from irregularities in finish as described herein. Aluminum finishing tools shall not be used.

B. Formed Surfaces: No treatment is required after form removal except for curing, repair or defective concrete, and treatment of surface defects. Where architectural finish is required, it shall be as specified or as shown.

1. Surface holes larger than ½ inch in diameter or deeper than ¼ inch are defined as surface defects in basins and exposed walls.

C. Unformed Surfaces: After proper and adequate vibration and tamping, all unformed top surfaces of slabs, floors, walls, and curbs shall be brought to a uniform surface with suitable tools. Immediately after the concrete has been screeded, it shall be treated with a liquid evaporation retardant. The retardant shall be used again after each Work operation as necessary to prevent drying shrinkage cracks. The classes of finish specified for unformed concrete surfaces are designated and defined as follows:

1. FINISH U1 - Sufficient leveling and screeding to produce an even, uniform surface with surface irregularities not to exceed 3/8-inch. No further special finish is required.

2. FINISH U2 - After sufficient stiffening of the screeded concrete, surfaces shall be float finished with wood or metal floats or with a finishing machine using float blades. Excessive floating of surfaces while the concrete is plastic and dusting of dry cement and sand on the concrete surface to absorb excess moisture will not be permitted. Floating shall be the minimum necessary to produce a surface that is free from screed marks and is uniform in texture. Surface irregularities shall not exceed 1/4-inch. Joints and edges shall be tooled where shown or as determined by the Engineer.

3. FINISH U3 - After the floated surface (as specified for Finish U2) has hardened sufficiently to prevent excess of fine material from being drawn to the surface, steel troweling shall be performed with firm pressure such as will flatten the sandy texture of the floated surface and produce a dense, uniform surface free from blemishes, ripples, and trowel marks. The finish shall be smooth and free of all irregularities.

4. FINISH U4 - Steel trowel finish (as specified for Finish U3) without local depressions or high points. In addition, the surface shall be given a light hairbroom finish with brooming perpendicular to drainage unless otherwise shown. The resulting surface shall be rough enough to provide a nonskid finish.

D. Unformed surfaces shall be finished according to the following schedule:

UNFORMED SURFACE FINISH SCHEDULE

Area	Finish
Grade slabs and foundations to be covered with concrete or fill material	U1
Floors to be covered with grouted tile or topping grout	U2
Slabs which are water bearing with slopes 10 percent and less	U4
Sloping slabs which are water bearing with slopes greater than 10 percent	U4
Slabs not water bearing	U4
Slabs to be covered with built-up roofing	U2
Interior slabs and floors to receive architectural finish	U3
Top surface of walls	U4

E. Floor Hardener (Surface Applied) - Required

1. Provide concrete with the following additional requirements:

   a) Maximum slump of 4 inches when peak ambient temperatures are expected to be more than 65°*F*, and no more than 3 inches when ambient temperatures are below 65°*F*.

   b) Maximum air content of 3 percent.

c) Do not use calcium chloride or set-accelerating admixtures containing calcium chloride.

d) Do not use admixtures that increase bleeding.

e) Do not use fly ash.

2. After the concrete has been leveled and as soon as the concrete will support an operator and machine without disturbing the level or working up excessive fines, float the surface of the slab with a mechanical float fitted with float shoes. Following floating, apply 1/2 to 2/3 of the total amount of dry shake surface hardener so that a uniform distribution of surface hardener is obtained. The use of a mechanical spreader is recommended. Once the shake has absorbed sufficient moisture (indicated by the darkening of the shake), float the surface. Immediately apply the remaining 1/3 to 1/2 of the shake and allow to absorb moisture. Do not place dry shake on concrete surface when bleed water is present.

3. Use finishing machines with detachable float shoes. Compact surface by a third mechanical floating if time and setting characteristics of the concrete will allow. Do not add water to the surface.

4. As surface further stiffens, indicated by loss of sheen, hand or mechanically trowel with blades set relatively flat. Remove all marks and pinholes in the final raised trowel operation.

5. Follow all application instructions of the floor surface hardener manufacturer.

6. Cure finished floors using fill-forming curing compound recommended by surface hardener manufacturer. Uniformly apply curing compound over the entire surface at a coverage that will provide moisture retention in excess of the requirements of ASTM C 309. Maintain ambient temperature of 50°*F* or above during the curing period.

7. Keep floors covered and free of traffic and loads for a minimum of 14 days after completion.

3.08 ARCHITECTURAL FINISH

A. General: Architectural finishes shall be required only where specifically called out on the Plans. In all other cases, the paragraph above, entitled "Finishing Concrete Surfaces", shall apply.

1. Immediately after the forms have been stripped, the concrete surface shall be inspected and any poor joints, voids, rock pockets, or other defective areas shall be repaired and all form-tie holes filled as indicated herein.

2. Architectural finishes shall not be applied until the concrete surface has been repaired as required and the concrete has cured at least 14 days.

3. All architecturally treated concrete surfaces shall conform to the accepted sample required herein in texture, color, and quality. It shall be the Contractor's responsibility to maintain and protect the concrete finish.

B. Smooth Concrete Finish:

1. The concrete surface shall be wetted, and a grout shall be applied with a brush. The grout shall be prepared by mixing one (1) part Portland Cement and one (1) part of fine sand that will pass a No. 16 sieve with sufficient water to give it the consistency of thick paint. The cement used in said grout shall be 1/2 gray and 1/2 white Portland Cement, as determined by the Engineer. White Portland Cement shall be Atlas White or equal. Calcium chloride in the amount of 5 percent by volume of the cement shall be used in the brush coat. The freshly applied grout shall be vigorously rubbed into the concrete surface with a wood float filling all small air holes. After all surface grout had been removed with a steel trowel, the surface shall be allowed to dry and, when dry, shall be vigorously rubbed with burlap to remove completely all surface grout so that there is no visible paint-like film of grout on the concrete. The entire cleaning operation for any area shall be completed the day it is started, and no grout shall be left on the surface overnight.

2. Cleaning operations for any given day shall be terminated at panel joints. It is essential that the various operations be carefully timed to secure the desired effect which is a light-colored concrete surface of uniform color and texture without any appearance of a point or grout film.

3. In the event that improper manipulation results in an inferior finish, rub such inferior areas with carborundum bricks.

4. Before beginning any of the final treatment on exposed surfaces, treat in a satisfactory manner a trial area of at least 200 square feet in some inconspicuous place selected by the Engineer and preserve said trial area undisturbed until the completion of the job.

C. Sandblasted Concrete Finish:

1. Sandblasting shall be done in a safe manner acceptable to local authorities and per OSHA requirements. The sandblasting shall be a light sandblast to remove laitance and to produce a uniform fine aggregate surface texture with approximately 1/32 to 1/16 inch of surface sandblasted off. Corners, patches, form panel joints, and soft spots shall be sandblasted with care.

2. A 3 square foot sample panel of the sandblasted finish shall be provided by the Contractor for acceptance by the Engineer before staring the sandblasting Work. The sample panel shall include a corner, plugs, and joints and shall be marked after approval. All other sandblasting shall be equal in finish to the sample panel.

3. Protection against sandblasting shall be provided on all surfaces and materials not requiring sandblasting but within or adjacent to areas being sandblasted. After sandblasting, the concrete surfaces shall be washed with clean water and excess sand removed.

3.09 CURING AND DAMP-PROOFING

A. General: All concrete shall be cured for not less than 14 days after placing, in accordance with the methods specified herein for the different parts of the Work, and described in detail in the following paragraphs:

Surface To Be Cured or Damp-proofed	Method

Unstripped forms	1
Wall sections with forms removed	6
Construction joints between footings and walls, and between floor slab and columns	2
Encasement concrete and thrust blocks	3
All concrete surfaces not specifically provided for elsewhere in this Paragraph	6
Floor slabs on grade	6
Slabs not on grade	6

B. Method 1: Wooden forms shall be wetted immediately after concrete has been placed and shall be kept wet with water until removed. If steel forms are used the exposed concrete surfaces shall be kept continuously wet until the forms are removed. If forms are removed within 14 days of placing the concrete, curing shall be continued in accordance with Method 6, herein.

C. Method 2: The surface shall be covered with burlap mats which shall be kept wet with water for the duration of the curing period, until the concrete in the walls has been placed. No curing compound shall be applied to surfaces cured under Method 2.

D. Method 3: The surface shall be covered with moist earth not less than 4 hours, nor more than 24 hours, after the concrete is placed. Earthwork operations that may damage the concrete shall not begin until at least 7 days after placement of concrete.

E. Method 4: The surface shall be sprayed with a liquid curing compound.

1. It shall be applied in accordance with the manufacturer's printed instructions at a maximum coverage rate of 200 square feet per gallon and in such a manner as to cover the surface with a uniform film which will seal thoroughly.

2. Where the curing compound method is used, care shall be exercised to avoid damage to the seal during the curing period. Should the seal be damaged or broken before the expiration of the curing period, the break shall be repaired immediately by the new application of additional curing compound over the damaged portion.

3. Wherever curing compound may have been applied by mistake to surfaces against which concrete subsequently is to be placed and to which it is to adhere, said compound shall be entirely removed by wet sandblasting just before the placing of new concrete.

4. Where curing compound is specified, it shall be applied as soon as the concrete has hardened enough to prevent marring on unformed surfaces, and within 2 hours after removal of forms from contact with formed surfaces. Repairs required to be made to formed surfaces shall be made within the said 2 hour period; provided, however, that any such repairs which cannot be made within the said 2 hour period shall be delayed until after the curing compound has been applied. When repairs are to be made to an area on which curing compound has

been applied, the area involved shall first be wet-sandblasted to remove the curing compound, following which repairs shall be made as specified herein.

5. At all locations where concrete is placed adjacent to a panel which has been coated with curing compound, the previously coated panel shall have curing compound reapplied to an area within 6 feet of the joint and to any other location where the curing membrane has been disturbed.

6. Before final acceptance of the Work, all visible traces of curing compound shall be removed from all surfaces in such a manner that does not damage surface finish.

F. Method 5:

1. Until the concrete surface is covered with curing compound, the entire surface shall be kept damp by applying water using nozzles that atomize the flow so that the surface is not marred or washed. The concrete shall be given a coat of curing compound in accordance with Method 4, herein. Not less than 1 hour nor more than 4 hours after the coat of curing compound has been applied, the surface shall be wetted with water delivered through a fog nozzle, and concrete-curing blankets shall be placed on the slabs. The curing blankets shall be polyethylene sheet, polyethylene-coated waterproof paper sheeting or polyethylene-coated burlap. The blankets shall be laid with the edges butted together and with the joints between strips sealed with 2 inch wide strips of sealing tape or with edges lapped not less than 3 inches and fastened together with a waterproof cement to form a continuous watertight joint.

2. The curing blankets shall be left in place during the 14 day curing period and shall not be removed until after concrete for adjacent Work has been placed. Should the curing blankets become torn or otherwise ineffective, replace damaged sections. During the first 3 days of the curing period, no traffic of any nature and no depositing, temporary or otherwise, of any materials shall be permitted on the curing blankets. During the remainder of the curing period, foot traffic and temporary depositing of materials that impose light pressure will be permitted only on top of plywood sheets 5/8 inch minimum thickness, laid over the curing blanket. Add water under the curing blanket as often as necessary to maintain damp concrete surfaces at all times.

G. Method 6: This method applies to both walls and slabs.

1. The concrete shall be kept continuously wet by the application of water for a minimum period of at least 14 consecutive days, beginning immediately after the concrete has reached final set or forms have been removed or until the concrete surface is covered with the curing medium. The entire surface shall be kept damp by applying water using nozzles that atomize the flow so that the surface is not marred or washed.

2. Heavy curing mats shall be used as a curing medium to retain the moisture during the curing period. The curing medium shall be weighted or otherwise held in place to prevent being dislodged by wind or any other causes and to be substantially in contact with the concrete surface. All edges shall be continuously held in place.

3. The curing blankets and concrete shall be kept continuously wet by the use of sprinklers or other means both during and after normal working hours. The

concrete shall be maintained in a cool condition from the heat of hydration and the solar heat of the sun.

4. Immediately after the application of water has terminated at the end of the curing period, the curing medium shall be removed, any dry spots shall be rewetted, and curing compound shall be immediately applied in accordance with Method 4, herein.

5. Dispose of excess water from the curing operation to avoid damage to the Work.

H. Damp-proofing: The exterior surface of all buried roof slabs shall be damp-proofed as follows:

1. Immediately after completion of curing the surface shall be sprayed with a damp-proofing agent consisting of an asphalt emulsion. Application shall be in two (2) coats. The first coat shall be diluted to 1/2 strength by the addition of water and shall be sprayed on so as to provide a maximum coverage rate of 100 square feet per gallon of dilute solution. The second coat shall consist of an application of the specified material, undiluted, and shall be sprayed on so as to provide a maximum coverage rate of 100 square feet per gallon. Damp-proofing material shall be as specified herein.

2. As soon as the asphalt emulsion, applied as specified herein, has taken an initial set, the entire area thus coated shall be coated with whitewash. Any formula for mixing the whitewash may be used which produces a uniformly coated white surface and which so remains until placing of the backfill. Should the whitewash fail to remain on the surface until the backfill is placed, apply additional whitewash.

3.10 PROTECTION

A. Protect all concrete against injury until final acceptance by the Owner.

B. Fresh concrete shall be protected from damage due to rain, hail, sleet, or snow. Provide such protection while the concrete is still plastic and whenever such precipitation is imminent or occurring.

3.11 CURING IN COLD WEATHER

A. Water curing of concrete may be reduced to 6 days during periods when the mean daily temperature in the vicinity of the worksite is less than 40°*F*; provided that, during the prescribed period of water curing, when temperatures are such that concrete surfaces may freeze, water curing shall be temporarily discontinued.

B. Concrete cured by an application of curing compound will require no additional protection from freezing if the protection at 50°*F* for 72 hours is obtained by means of approved insulation in contact with the forms or concrete surfaces; otherwise the concrete shall be protected against freezing temperatures for 72 hours immediately following 72 hours protection at 50°*F*. Concrete cured by water curing shall be protected against freezing temperatures for 3 days immediately following the 72 hours of protection at 50°*F*.

C. Discontinuance of protection against freezing temperatures shall be such that the drop in temperature of any portion of the concrete will be gradual and will not exceed 40°*F* in 24 hours. In the spring, when the mean daily temperature rises above 40°*F* for more than 3 successive days, the specified 72 hour protection at a temperature not lower than 50°*F*

may be discontinued for as long as the mean daily temperature remains above 40°*F;* provided, that the concrete shall be protected against freezing temperatures for not less than 48 hours after placement.

D. Where artificial heat is employed, special care shall be taken to prevent the concrete from drying. Use of unvented heaters will be permitted only when unformed surfaces of concrete adjacent to the heaters are protected for the first 24 hours from an excessive carbon dioxide atmosphere by application of curing compound; provided, that the use of curing compound for such surfaces is otherwise permitted by these Specifications.

3.12 TREATMENT OF SURFACE DEFECTS

A. As soon as forms are removed, all exposed surfaces shall be carefully examined and any irregularities shall be immediately rubbed or ground in a satisfactory manner in order to secure a smooth, uniform, and continuous surface. Plastering or coating of surfaces to be smoothed will not be permitted. No repairs shall be made until after inspection by the Engineer. In no case will extensive patching of honeycombed concrete be permitted. Concrete containing minor voids, holes, honeycombing, or similar depression defects shall have them repaired as specified herein. Concrete containing extensive voids, holes, honeycombing, or similar depression defects, shall be completely removed and replaced. All repairs and replacements herein specified shall be promptly executed by the Contractor at its own expense.

B. Defective surfaces to be repaired shall be cut back from trueline in a minimum depth of ½ inch over the entire area. Feathered edges will not be permitted. Where chipping or cutting tools are not required in order to deepen the area properly, the surface shall be prepared for bonding by the removal of all laitance or soft material, and not less than 1/32 inch depth of the surface film from all hard portions, by means of an efficient sandblast. After cutting and sandblasting, the surface shall be wetted sufficiently in advance of shooting with shotcrete or with cement mortar so that while the repair material is being applied, the surfaces under repair will remain moist, but not so wet as to overcome the suction upon which a good bond depends. The material used for repair proposed shall consist of a mixture of 1 sack of cement to 3 cubic feet of sand. For exposed walls, the cement shall contain such a proportion of Atlas White Portland Cement as is required to make the color of the patch match the color of the surrounding concrete.

C. Holes left by tie-rod cones shall be reamed with suitable toothed reamers so as to leave the surfaces of the holes clean and rough. These holes then shall be repaired in an approved manner with dry-packed cement grout. Holes left by form-tying devices having a rectangular cross-section, and other imperfections having a depth greater than their least surface dimension, shall not be reamed but shall be repaired in an approved manner with dry-packed cement grout.

D. All repairs shall be built up and shaped in such a manner that the completed Work will conform to the requirements of this Section, as applicable, using approved methods which will not disturb the bond, cause sagging, or cause horizontal fractures. Surfaces of said repairs shall receive the same kind and amount of curing treatment as required for the concrete in the repaired section.

E. Before filling any structure with water, all cracks that may have developed shall be "vee'd" and filled with construction joint sealant for water-bearing structures conforming to the materials and methods specified in Section 03290 - Joints in Concrete Structures. This repair method shall be accomplished on the water bearing face of members. Before backfilling, faces of members in contact with fill, which are not covered with a waterproofing membrane, shall also have cracks repaired as specified herein.

3.13 PATCHING HOLES IN CONCRETE

A. Patching Small Holes:

1. Holes which are less than 12 inches in their least dimension and extend completely through concrete members, shall be filled as specified herein.

2. Small holes in members which are water-bearing or in contact with soil or other fill materials, shall be filled with nonshrink grout. Where a face of the member is exposed to view, the nonshrink grout shall be held back 2 inches from the finished surface. The remaining 2 inches shall then be patched according to the paragraph in Part 3 entitled - Treatment of Surface Defects.

3. Small holes through all other concrete members shall be filled with nonshrink grout, with exposed faces treated as above.

B. Patching Large Holes:

1. Holes which are larger than 12 inches in their least dimension, shall have a keyway chipped into the edge of the opening all around, unless a formed keyway exists. The holes shall then be filled with concrete as specified.

2. Holes which are larger than 24 inches in their least dimension and which do not have reinforcing steel extending from the existing concrete, shall have reinforcing steel set in grout in drilled holes. The reinforcing added shall match the reinforcing in the existing wall unless required otherwise by the Improvement Plans or approved shop drawings.

3. Large holes in members which are water bearing or in contact with soil or other fill, shall have a bentonite type waterstop material placed around the perimeter of the hole as specified in the Section 03290 - Joints in Concrete Structures, unless there is an existing waterstop in place.

3.14 CARE AND REPAIR OF CONCRETE

A. The Contractor shall protect all concrete against injury or damage from excessive heat, lack of moisture, overstress, or any other cause until final acceptance by the Owner. Particular care shall be taken to prevent the drying of concrete and to avoid roughening or otherwise damaging the surface. Any concrete found to be damaged, or which may have been originally defective, or which becomes defective at any time before the final acceptance of the completed Work, or which departs from the established line or grade, or which, for any other reason, does not conform to the requirements of the Contract Documents, shall be satisfactorily repaired or removed and replaced with acceptable concrete at the Contractor's expense.

END OF SECTION

SECTION 03315 - GROUT

PART 1 - GENERAL

1.01 DESCRIPTION

A. The Contractor shall provide grout in accordance with the Contract Documents.

B. The following types of grout shall be covered in this Section:

1. Cement Grout

2. Packaged Grout

A. Nonshrink Grout: This type of grout is to be used wherever grout is illustrated in the Contract Documents unless another type is specifically referenced.

B. Epoxy Grout

C. Pump and Motor Grout

3. Topping Grout and Concrete Fill

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. The Work of the following Sections apply to the Work of this Section. Other Sections, not referenced below, shall also apply to the extent required for proper performance of this Work.

1. Section 03300 - Cast-in-Place Concrete.

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Commercial Standards:

1. CRD-C 621 Corps of Engineers Specification for Non-Shrink Grout

B. National Sanitation Foundation

1. NSF / ANSI 61: Drinking Water System Components – Health Effects

C. ASTM Standard in Building Codes:

1. ASTM C 109: Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in or 50-mm Cube Specimens)

2. ASTM C 531: Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical Resistant Mortars, Grouts, and Monolithic Surfacings

3. ASTM C 579: Test Methods for Compressive Strength of Chemical Resistant Mortars, Grouts, and Monolithic Surfacings

4. ASTM C 827: Test Method for Change in Height at Early Ages of Cylindrical Specimens from Cementitious Mixture

5. ASTM C 881: Specification for Epoxy-Resin-Base Bonding System for Concrete

6. ASTM C 882: Standard Test for Bond Strength of Epoxy-Resin Systems Used with Concrete

7. ASTM C 884: Standard Test Method for Thermal Compatibility between Concrete and an Epoxy-Resin Overlay

8. ASTM D 638: Standard Test Methods for Tensile Properties of Plastics

9. ASTM D 696: Test Method for Coefficient of Linear Thermal Expansion of Plastics

10. ASTM D 2471: Standard Test Methods for Gel Time and Peak Exothermic Temperature of Reacting Thermosetting Resins

1.04 CONTRACTOR SUBMITTALS

A. The Contractor shall submit certified test results verifying the compressive strength, shrinkage, and expansion requirements indicated herein; and manufacturer's literature containing instructions and recommendations on the mixing, handling, placement and appropriate uses for each type of nonshrink and epoxy grout used in the Work in accordance with the requirements of the Specification Section 01330 – Submittals/Shop Drawings.

1.05 QUALITY ASSURANCE

A. Field Tests:

1. Compression test specimens will be taken during construction from the first placement of each type of grout, and at intervals thereafter as selected by the Owner's Representative to ensure continued compliance with these Specifications. The specimens will be prepared by a Geotechnical Consultant/Laboratory to be compensated by the Contractor. The Owner's Representative shall approve the Geotechnical Consultant/Laboratory firm.

2. Compression tests and fabrication of specimens for cement grout and nonshrink grout shall be performed as specified in ASTM C 109 at intervals during construction as determined by the Owner's Representative. A set of three (3) specimens will be prepared for testing at 7 days, 28 days, and each additional time period as appropriate. The Contractor shall bear the expenses related to this item.

3. Compression tests and fabrication of specimens for epoxy grout shall be performed as specified in ASTM C 579, Method B, at intervals during construction as determined by the Owner's Representative. A set of three (3) specimens will be prepared for testing at 7 days, and each earlier time period as appropriate. The Contractor shall bear the expenses relative to this item.

4. Placed grout, which fails to meet the requirements of these Specifications, is subject to removal and replacement at no additional cost to the Owner.

5. The cost of all laboratory tests on grout will be borne by the Contractor. The Contractor shall assist the approved Geotechnical Consultant/Laboratory Firm in

obtaining specimens for testing. The Contractor shall also be responsible, without additional cost to the Owner, for additional tests and investigation on work performed which is non-compliant with the Specifications. The Geotechnical Consultant/Laboratory Firm shall supply all materials necessary for fabricating the test specimens.

B. Construction Tolerances: Construction tolerances shall be as specified in the Section 03300 - Cast-in-Place Concrete, except as modified herein or elsewhere in the Contract Documents.

PART 2 - PRODUCTS

2.01 CEMENT GROUT

A. Cement Grout: Cement grout shall be composed of one part cement, three parts sand, and the minimum amount of water necessary to obtain the desired consistency. Where needed to match the color of adjacent concrete, white Portland Cement shall be blended with regular cement as needed. The minimum compressive strength at 28 days shall be 5,000 PSI.

B. Cement grout materials shall be as specified in Section 03300 - Cast-in-Place Concrete.

2.02 PREPACKAGED GROUTS

A. Nonshrink Grout:

1. Nonshrink grout shall be a prepackaged, inorganic, nongas-liberating, nonmetallic, cement-based grout requiring only the addition of water. The manufacturer's instructions shall be printed on each bag or other container in which the materials are packaged. The specific formulation for each class of nonshrink grout indicated herein shall be that recommended by the manufacturer for the particular application.

2. Class A nonshrink grouts shall have a minimum 28 day compressive strength of 6,000 PSI; shall have no shrinkage (0.0 percent) and a maximum 4.0 percent expansion in the plastic state when tested in accordance with ASTM C 827; and shall have no shrinkage (0.0 percent) and a maximum of 0.2 percent expansion in the hardened state when tested in accordance with CRD-C 621.

3. Class B nonshrink grouts shall have a minimum 28-day compressive strength of 5,000 PSI and shall meet the requirements of CRD-C 621.

4. Application:

a) Class A nonshrink grout shall be used for the repair of all holes and defects in concrete members which are water bearing or in contact with soil or other fill material, grouting under all equipment base plates, and at all locations where grout is indicated; except, for the applications of Class B nonshrink grout and epoxy grout indicated herein. Class A nonshrink grout may be used in place of Class B nonshrink grout for all applications.

b) Class B nonshrink grout shall be used for the repair of all holes and defects in concrete members which are not water bearing and not in contact with soil or other fill material, grouting under all base plates for structural steel members, and grouting railing posts in place.

B. Epoxy Grout:

1. Epoxy grout shall be a pourable, nonshrink, 100 percent solids system. The epoxy grout system shall have three components: resin, hardener, and specially blended aggregate, all premeasured and prepackaged. The resin component shall not contain any nonreactive diluents. Resins containing butyl glycidyl either (BGE) or other highly volatile and hazardous reactive diluents are not acceptable. Variation of component ratios is not permitted unless specifically recommended by the manufacturer. Manufacturer's instructions shall be printed on each container in which the materials are packaged. Epoxy grout shall be BurkEpoxy Anchoring Grout by The Burke Company, Sika or an approved equal.

2. The chemical formulation of the epoxy grout shall be that recommended by the manufacturer for the particular application.

3. The mixed epoxy grout system shall have a minimum working life of 45 minutes at 75°*F*.

4. The epoxy grout shall develop a compressive strength of 5,000 PSI in 24 hours and 10,000 PSI in 7 days when tested in accordance with ASTM C 579, Method B. There shall be no shrinkage (0.0 percent) and a maximum 4.0 percent expansion when tested in accordance with ASTM C 827.

5. The epoxy grout shall exhibit a minimum effective bearing area of 95 percent. This shall be determined by a test consisting of filling a 2 inch diameter by 4 inch high metal cylinder mold covered with a glass plate coated with a release agent. A weight shall be placed on the glass plate. At 24 hours after casting, the weight and plate shall be removed and the void area in the plate measured. The surface of the grout shall be probed with a sharp instrument to locate all voids.

6. The peak exotherm of a 2-inch diameter by 4 inch high cylinder shall not exceed 95°*F* when tested with 75°*F* material at laboratory temperature. The epoxy grout shall exhibit a maximum thermal coefficient of 30×10^{-6} inches/inch/degree *F* when tested according to ASTM C 531 or ASTM D 696.

7. Application: Epoxy grout shall be used to embed all anchor bolts and reinforcing steel required to be set in grout, and for all other applications in the Contract Documents where grout type is not specifically indicated.

8. For crack repair, the Contractor shall use pressure injection epoxy grout as recommended by the manufacturer and approved by the Owner's Representative.

C. Grout for Pumps and Motors

1. Grout for pumps and motors shall be epoxy grouts meeting the following minimum requirements:

a) Creep shall be less than 0.005 in/in when tested by ASTM C 881 method. The test shall be at 70°*F* and 140°*F* with a load of 400 PSI.

b) Linear shrinkage shall be less than 0.080 percent and thermal expansion less than 17 x 10^{-6} in/in/degree *F* when tested by ASTM C 531.

c) The compressive strength shall be a minimum of 12,000 PSI in 7 days when tested by ASTM C 579 Method 8, modified.

d) Bond strength of grout to Portland Cement concrete shall be greater than 2,000 PSI when using ASTM C 882 test method.

e) Grout shall pass the thermal compatibility test when overlayed on Portland Cement concrete using test method ASTM C 884.

f) Tensile strength and modulus of elasticity shall be determined by ASTM D 638. The tensile strength shall not be less than 1,700 PSI and the modulus of elasticity shall not be less than 1.8 x 10^{6} PSI.

g) Gel time and peak exothermic temperature shall be determined by ASTM D 2471. Peak exothermic temperature shall not exceed 110° *F* when a specimen 6 inches in diameter by 12 inches high is used. Gel time shall be at least 150 minutes.

h) The grout shall be suitable for supporting precision machinery subject to high impact and shock loading in industrial environments while exposed to elevated temperatures as high as 150°*F*, with a load of 2,000 PSI.

2. Primer, if required, shall conform to the written recommendations of the grout manufacturer.

3. Surface preparations shall conform to the written recommendations of the grout manufacturer.

4. Placement and Curing:

a) Placement and curing procedures shall be in accordance with the written recommendations of the grout manufacturer.

b) A grouting performance demonstration/training session shall be conduced by the grout manufacturer's representative prior to foundation and base plate preparation and the first grouting on site. This training session shall demonstrate proper preparation and installation methods and that the grouting material meets the strength requirements.

5. Grout shall be Escoweld, Chockfast Red Epoxy Grout as manufactured by Philadelphia Resin Corp.; Five Star DP Epoxy Grout as manufactured by Five Star Products, Inc.; or equal.

2.03 TOPPING GROUT AND CONCRETE FILL

A. Grout for topping of slabs and concrete fill for built-up surfaces of tank, channel, and basin bottoms shall be composed of cement, fine aggregate, coarse aggregate, water, and admixtures proportioned and mixed as specified herein. All materials and procedures specified for normal concrete in Section 03300 - Cast-in-Place Concrete, shall apply except as noted otherwise herein.

B. Topping grout and concrete fill shall contain a minimum of 564 pounds of cement per cubic yard with a maximum water cement ratio of 0.45. Where concrete fill is thicker than 3 inches, sitework concrete, as specified in Section 03300 - Cast-in-Place Concrete, may be used when accepted by the Owner's Representative.

C. Coarse aggregate shall be graded as follows:

U.S. Standard Sieve Size	Percent by Weight Passing
1/2"	100
3/8"	90 - 100
No. 4	20 - 55
No. 8	5 - 30
No. 16	0 - 10
No. 30	0

D. Final mix design shall be as determined by trial mix design under supervision of the approved testing laboratory.

E. Strength: Minimum compressive strength of topping grout and concrete fill at the end of 28 days shall be 4,000 PSI.

2.04 CURING MATERIALS

A. Curing materials shall be as specified in Section 03300 - Cast-in-Place Concrete for cement grout and as recommended by the manufacturer of prepackaged grouts.

2.05 MEASUREMENT OF INGREDIENTS

A. Measurements for cement grout shall be made accurately by volume using containers. Shovel measurement shall not be allowed.

B. Prepackaged grouts shall have ingredients measured by means recommended by the manufacturer.

2.06 NSF / ANSI STANDARD 61

A. All cementitious material, admixtures, curing compounds, and other industrial produced materials used in concrete, or for curing or repairing of concrete, that can contact potable water or water that will be treated to become potable shall be listed in NSF / ANSI Standard 61.

PART 3 - EXECUTION

3.01 GENERAL

A. All surface preparation, curing, and protection of cement grout shall be as indicated in Section 03300 - Cast-in-Place Concrete. The finish of the grout surface shall match that of the adjacent concrete.

B. The manufacturer of Class A nonshrink grout and epoxy grout shall provide on-site technical assistance to Contractor upon request.

C. Base concrete or masonry must have attained its design strength before grout is placed, unless authorized by the Owner's Representative.

D. The consistency of grouts shall be that necessary to completely fill the space to be grouted for the particular application. Dry pack consistency is such that the grout is plastic and moldable but will not flow. Where "dry pack" is called for in the Contract Documents, it shall mean a grout of that consistency; the type of grout to be used shall be as indicated herein for the particular application.

E. The slump for topping grout and concrete fill shall be adjusted to match placement and finishing conditions but shall not exceed 4 inches.

3.02 GROUTING PROCEDURES

A. Prepackage Grouts: All mixing, surface preparation, handling, placing, consolidation, curing, and other means of execution for prepackaged grouts shall be accomplished according to the instructions and recommendations of the manufacturer.

B. Base Plate Grouting:

1. For base plates, the original concrete shall be blocked out or finished off a sufficient distance below the plate to provide for a minimum 1 inch thickness of grout or a thickness as indicated on the Plans.

2. After the base plate has been set in position at the proper elevation by steel wedges or double nuts on the anchor bolts, the space between the bottom of the plate and the original pour of concrete shall be filled with non-shrink-type grout. The mixture shall be of a trowelable consistency and tamped or rodded solidly into the space between the plate and the base concrete. A backing board or stop shall be provided at the back side of the space to be filled with grout. Where this method of placement is not practical or where required by the Owner's Representative, alternate grouting methods shall be submitted for acceptance by the Owner's Representative.

C. Topping Grout and Concrete Fill:

1. All mechanical, electrical, and finish Work shall be completed prior to placement of topping or concrete fill. The base slab shall be given a roughened textured surface by sandblasting or hydroblasting exposing the aggregates to ensure bonding to the base slab.

2. The minimum thickness of grout topping and concrete fill shall be one inch (1") unless otherwise specified by the Plans. Where the finished surface of concrete fill is to form an intersecting angle of less than 45° with the concrete surface it is to be placed against, a key shall be formed in the concrete surface at the intersection point. The key shall be a minimum of 3-1/2 inches wide by 1-1/2 inches deep.

3. The base slab shall be thoroughly cleaned and wetted prior to placing topping or concrete fill. No topping or concrete fill shall be placed until the slab is free from standing pools, ponds of water. A thin coat of neat Type II cement grout shall be broomed onto the surface of the slab just before topping or concrete fill placement. The topping or concrete fill shall be compacted by rolling or tamping, brought to established grade, and floated. Grouted concrete fill for tank and basin bottoms where scraping mechanism are to be installed shall be

screeded by blades attached to the revolving mechanism of the equipment in accordance with the procedures outlined by the equipment manufacturer after the grout is brought to the established grade.

4. Topping grout placed on sloping slabs shall proceed uniformly from the bottom of the slab to the top, for the full width of the placement.

5. The surface shall be tested with a straight edge to detect high and low spots which shall be immediately eliminated. When the topping or concrete fill have hardened sufficiently, it shall be steel troweled to a smooth surface free from pinholes and other imperfections. An approved type of mechanical trowel may be used to assist in this operation, but the last pass over the surface shall be by hand-troweling. During finishing, no water, dry cement or mixture of dry cement and sand shall be applied to the surface.

3.03 CONSOLIDATION

A. Grout shall be placed in such a manner, for the consistency necessary for each application, so as to assure that the space to be grouted is completely filled.

END OF SECTION

SECTION 03400 - PRECAST CONCRETE

PART 1 -- GENERAL

1.01 DESCRIPTION

A. The Contractor shall furnish all tools, equipment, materials, and supplies and shall perform all labor required to complete the precast concrete work in accordance with the Contract Documents.

B. This Section covers the design, fabrication, delivery, and installation of all plant precast concrete units, including connections, complete, in place, as shown and specified.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 03315 - Grout

B. Section 07900 – Sealants and Caulking

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Comply with reference standards of the General Requirements.

B. Comply with the current provisions of the following Codes and Standards, as applicable:

1. Commercial Standards:

ACI 301	Specifications for Structural Concrete
ACI 304	Guide for Measuring, Mixing, Transporting and Placing Concrete
ACI 311	Guide for Concrete Plant Inspection and Testing of Ready-Mixed Concrete
ACI 315	Details and Detailing of Concrete Reinforcement
ACI 318	Building Code Requirements for Reinforced Concrete
ACI 347	Guide to Formwork for Concrete
AWS A5.4	Welding Rods and Electrodes
AWS D1.1	Welding and Cutting
AWS D1.4	Structural Welding Code – Reinforcing Steel
ASTM A 184	Specification for Fabricated Deformed Steel Bar Mats for Concrete Reinforcement
ASTM A 185	Specification for Steel Welded Wire, Fabric, Plain, for Concrete Reinforcement
ASTM A 193	Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service

ASTM A 194	Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure and High-Temperature Service
ASTM A 351	Specification for Steel Castings, Austenitic, for High-Temperature Service
ASTM A 497	Specification for Welded Deformed Steel Wire Fabric for Concrete Reinforcement
ASTM A 580	Specification for Stainless and Heat-Resisting Steel Wire
ASTM A 615	Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
ASTM A 666	Specification for Austenitic Stainless Steel, Sheet, Strip, Plate, and Flat Bar for Structural Applications
ASTM A 775	Specifications for Epoxy-Coated Reinforcing Steel Bars
ASTM C 33	Specification for Concrete Aggregates
ASTM C 67	Method for Sampling and Testing Brick and Structural Clay Tile
ASTM C 127	Test Method for Specific Gravity and Absorption of Coarse Aggregate
ASTM C 128	Test Method for Specific Gravity and Absorption of Fine Aggregate
ASTM C 150	Specification for Portland Cement
ASTM C 173	Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
ASTM C 204	Test Method for Fineness of Portland Cement by Air Permeability Apparatus
ASTM C 231	Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C 260	Specification for Air-Entraining Admixtures for Concrete
ASTM C 311	Method for Sampling and Testing Fly Ash or Natural Pozzolans for Use as a Mineral Admixture in Portland Cement Concrete
ASTM C 494	Test Method for Shear Fatigue of Sandwich Core Materials

ASTM D 2240	Test Method for Rubber Property -- Durometer Hardness
AWS B2.1	Specification for Welding Procedure and Performance Qualification
PCI MNL-116	Manual for Quality Control for Plants and Production of Structural Precast Concrete Products
PCI MNL-117	Manual for Quality Control for Plants and Production of Architectural Precast Concrete Products
PCI MNL-121	Manual for Structural Design of Architectural Precast Concrete

2. Government Standards:

CSS	Caltrans Standard Specifications.

1.04 CONTRACTOR SUBMITTALS

A. Submittals shall be made in accordance with the General Requirements.

B. Shop Drawings:

1. Shop drawings shall provide details in accordance with ACI 315 and ACI 318 including installation details.

2. Shop drawings, including design computations, shall be stamped and signed by a Civil or Structural Engineer registered in the State of California and shall be approved by the Owner's Representative.

3. Shop drawings shall indicate precast unit identification marks, location of units in the Work, elevations, fabrication details, welding details, reinforcement, connections, dimensions, interface with adjacent members, and special handling instructions in sufficient detail to cover manufacture, handling, and erection. Shop drawings shall include erection drawings. Shop drawings shall also include design computations for above-mentioned drawings.

4. Shop drawings shall be divided into complete separate submittals for each structure. Each complete submittal shall consist of a panel schedule and shop drawings.

a. Panel Schedule: Showing all exterior elevations of the structure, including all precast concrete enclosure faces exposed to view, in its associated shop drawing submittal. Elevations at a minimum scale of 1/8" = 1'-0" shall be drawn, identifying the type and location of each panel by a number which corresponds to the panel number appearing on an associated shop drawing; this same number shall be permanently marked on the back of each panel as they are fabricated.

b. Shop Drawings: Showing all elevations, dimensions, horizontal and vertical sections, openings, inserts, reinforcing, anchorage devices, pick-up points, details, design computations, and other requirements for each different type of panel to be incorporated into the portion of the project

covered by the submittal. Drawings shall be 24 inches x 36 inches maximum.

c. For bridge structures, shop drawings for precast concrete piles shall conform to Section 49-3 of the CSS.

C. Small Samples:

1. Unless otherwise specified on the contract documents, two 72 inch by 72 inch samples of precast concrete unit finish shall be submitted, as required for the project. Each sample shall show matrix color, surface color, surface texture, and panel back finish.

2. When so requested by the Owner's Representative, submit samples of cast-in gaskets, anchorages and other attachments and accessories.

3. The face of each sample shall contain at least two areas of approved size and shape which have been chipped out and then patched and repaired and one form joint; the color, texture and appearance of patched areas and form joint shall match that of adjacent surface.

4. Samples will be inspected for color and texture match to the samples selected by the Owner's Representative, uniformity of color and texture throughout the panel and acceptability of patching and joint treatment. Exposed face of samples shall be tested for efflorescence in accordance with ASTM C 67; rating shall not be more than "slightly effloresced."

5. If the Owner's Representative rules a sample, or samples, to be unacceptable, the Contractor shall fabricate and resubmit additional samples at no additional cost to the Owner.

6. When approved, one sample will be kept at the Owner's Representative's office and the other shall be picked up by the Contractor and returned to the manufacturing plant. These sample panels will be used as a comparison to judge acceptability of the full-size panel samples and, where necessary, the production precast units.

D. Full-Size Panel Samples at Manufacturing Plant:

1. After the small samples and shop drawings have been approved, and prior to fabricating panels for the project, a full-size panel of specified color and each finish shall be produced and erected at the manufacturing plant for inspection and approval by the Owner's Representative.

2. The full-size panels shall be fabricated utilizing tools, forms, materials and techniques proposed and the dimensions, profile cross section, color and texture required for the project. Panels will be inspected for color and texture to match approved samples, uniformity of color and texture throughout the panel, accuracy and sharpness of shape, acceptability of patched and repaired areas, and form joint treatment.

3. If the Owner's Representative rules a sample to be unacceptable, the Contractor shall fabricate additional revised panel(s) at no additional cost to the Owner. When approved, panels shall be preserved, remain at the plant, and become the job standard against which all panels will be compared as they come off the production line.

E. Full-Size Panel Samples at Project Site: From the first loads of acceptable panels for the Project, the Owner's Representative will select one panel of each texture which is scheduled to be erected in a prominent location. If the Owner's Representative chooses, panels may be selected from a later load. The selected panel(s) together with the Small Sample from Section 1.4.C kept at the Owner's Representative's office, will become the Site standard against which all panels will be compared.

F. Mix Proportions: Prior to commencing operations, including fabrications of the precast concrete for any mock-up, a statement shall be submitted giving the nominal maximum aggregate size and proportions of all ingredients that will be used in the manufacture of concrete. The statement shall include test results from an approved testing laboratory, with certification stamp and signature by a Civil or Structural Engineer registered in the State of California. No substitutions shall be made in materials used in the concrete mix without approval and additional tests to verify that the concrete properties are satisfactory. A copy shall be submitted of concrete mix with each set of samples.

G. Test Reports: Tests for compressive strength of concrete shall be performed by an approved independent commercial testing laboratory at no cost to the Owner. Copies of test reports including all test data and all test results shall be submitted for review and approval of the Owner's Representative.

H. Certificates of Compliance: Certificates of compliance shall be submitted attesting that materials and products meet or exceed specified requirements.

I. Manufacturer's Qualifications: Prior to commencing operations, a statement shall be submitted giving the qualifications of the precast concrete Manufacturer, and evidence that the Manufacturer and plant are PCI certified.

1.05 QUALITY ASSURANCE

A. General Requirements: Design precast members under direct supervision of a Professional Structural Engineer experienced in design of precast concrete units, registered in the State of California and conforming to requirements of PCI MNL-121 and to ACI 318.

1. Precast Manufacturer and erectors shall be qualified in accordance with PCI MNL-117 and MNL-116.

2. Welding shall be in accordance with AWS D 1.1, AWS D 12.1, AWS B 2.1, and AWS A 5.4.

3. Manufacture, Transportation and Installation: The Manufacturer shall specialize in providing precast products and services normally associated with precast concrete construction with high quality architectural finishes similar to that indicated on the Plans, using procedures complying with PCI MNL-116 and MNL-117, and PCI plant certified for at least 5 years.

4. Use adequate number of skilled workers who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and methods needed for proper performance of the Work of this Section.

B. Sample:

1. Prebid samples representing the color, surface, texture and panel back finish specified and required for this project can be viewed at the Owner's Representative's office, by bidders and precast concrete Manufacturers prior to submitting bids.

2. It shall be the Contractor's responsibility to assure that all precast architectural concrete conforms to specified requirements for quality and appearance. The only appearance criterion is that all precast architectural finishes provided for this project conform in appearance, when viewed from a distance of 20 feet, to the design, color, and texture as represented by the prebid sample except that closeup inspection shall not exhibit any evidence of "bugholes" on exposed surfaces exceeding 1/8 inch and in quantity not more than 2 average per square foot.

C. Sample Construction (Building structures only):

1. A typical precast concrete combination sectioned wall and related perimeter window assembly shall be constructed and provided by the Contractor. This sample construction, after approval, shall serve for comparison as a sample of construction requirements for the rest of the building.

2. The precast concrete units shall structurally support the window assemblies and include anchorage inserts for windows as indicated. Use of drilled-in anchorage inserts for window supports and anchorage of other items is prohibited. Sample construction shall be sealed and finished as required for completed wall.

3. The sample construction shall demonstrate precast concrete units and window framing, sealants, anchorage, and other elements of construction. The sample construction will be inspected and judged for compliance with requirements and visual appearance including, but not limited to, uniformity of color and texture, acceptability of patching and repair, and conformance to required tolerances. If the sample does not provide an acceptable window assembly or meet visual appearance or tolerance requirements as determined by the Owner's Representative, the Contractor shall modify, repair, or reconstruct the sample at no additional cost.

4. At the Owner's Representative's request, the Contractor shall dispose of the sample at no cost to the Owner.

1.06 DESIGN REQUIREMENTS

A. General: The precast concrete panel and connection designs shown hereon represent minimum precast construction requirements. The Manufacturer shall verify the panel and connection designs for all handling, erection, and service conditions, and shall provide any additional materials necessary to meet the design conditions.

B. Standards and Loads (Building Structures only): The precast panel and connection design and construction shall conform to all applicable codes and AISC Specification for the Design, Fabrication and Erection of Structural Steel for Buildings. The precast or prefabricated, nonbearing, nonshear wall panels and connections which are attached to or enclose the exterior, shall resist, in addition to initial handling and erection loads and dead loads, the following forces:

1. Wind pressure and load combinations relative to panel design in accordance with the latest edition of the California Building Code.

2. Seismic loads relative to panel design in accordance with the latest edition of the California Building Code.

3. The design shall be based on a differential temperature of 50°*F* between interior and exterior faces of the units and 80°*F* (40 degrees from erected temperature) average panel temperature differential.

4. Stresses due to restrained volume changes caused by shrinkage and temperature differentials shall be accounted for.

C. Connections (Building Structures only): Prior to submitting shop drawings, the Contractor shall verify the precast connection designs shown against the aforementioned and following design criteria and provide any additional materials necessary to meet the design conditions.

1. The panel joints shall be designed to accommodate an in-plane movement between stories of 0.005 times the story height in inches but not less than ¾ inch.

2. Panel connections shall accommodate building movement and permit panels to move freely so as not to resist in plane deformation of the main frame structural system. Adjustment shall be provided to accommodate misalignment of structure without permanent distortion, damage to components, racking of joint connection, breakage of seals, or moisture penetration.

D. Concrete Mix: The concrete mix shall be designed by the Manufacturer, with certification stamp and signature by a Civil or Structural Engineer registered in the State of California, and approved by the Owner's Representative, using the materials and quantities specified to meet all of the requirements of this specification.

1. Proportioning of Concrete Mixes: Mixes shall be proportioned by weight except water and admixtures may be batched by volume if desired. Trial mixes and testing to meet requirements of the strengths of concrete specified is the Contractor's responsibility. Design mix shall contain similar materials as those proposed for use in the Work.

2. Admixtures: Concrete shall contain an air entraining admixture in proportion so as to provide 4 percent plus or minus 1 percent total air in the concrete as determined by ASTM C 173 or C 231. Set retarding admixtures may be used provided cement content is not reduced. Water reducing admixtures may be used provided they are used in the mix design studies. High-range water reducers (superplasticizers) shall be used only where specifically called for in this Section, otherwise superplasticizers shall not be used without written approval from the Owner's Representative. No admixture may contain chlorides, bromides, or fluorides.

3. Water: Clean, potable water. The Contractor shall provide tests to assure that no more than 200 parts per million total aggregated content of chlorides, bromides, and fluorides are present.

4. If a variance from the Local Authority is required for the precast concrete mix design, the Contractor shall be responsible for submitting and obtaining the 5,000 PSI precast concrete mix variance. The admixtures used in the mix design shall be used in approved combinations and proportions in accordance with the local requirements.

E. Formwork: Formwork shall be designed to withstand high-frequency vibration and to ensure finished units.

F. Pickup Points and Boxouts: Pickup points, boxouts, and inserts on panel faces and surfaces to be exposed are prohibited except as approved by the Owner's Representative.

1.07 DELIVERY, STORAGE AND HANDLING

A. General: Deliver precast concrete units to the job-site in such quantities and at such times as to assure the continuity of construction. Precast members shall be handled to position consistent with their shape and design; they shall be lifted and supported from design incorporated support points and provided with strong backs and other devices as required. Lifting or handling equipment shall be capable of maintaining units during manufacture, storage, transportation, erection, and in position for fastening.

B. Blocking and supports, lateral restraints and protective materials during transport and storage shall be clean, nonstaining, without causing harm to exposed surfaces, including temporary support to prevent bowing and warping. Lateral restraints shall be provided to prevent undesirable horizontal movement. Edges and exposed faces of members shall be protected to prevent straining, chipping, or spalling of concrete.

C. Units shall be marked with date of production and final position in structure in location not visible after erection.

D. Precast units shall be stored off the ground in a manner to keep markings visible, and to prevent cracking, distortion, warping, staining or other physical damage, and they shall be protected from weather, marring, and overload.

E. Stainless Steel Hardware: Stainless steel hardware shall be transported, handled, stored, and protected in wood crates.

PART 2 – PRODUCTS

2.01 CONCRETE MATERIALS

A. Cement: ASTM C 150, Type V, "low alkali," white color. "Low alkali" requirement may be waived if not reactive as defined in Appendix to ASTM C 33. Submit laboratory test reports.

B. Aggregate: ASTM C 33, ½ inch maximum coarse aggregate size fine aggregate ratio to total aggregate volume = 0.35 min, 0.55 max.

1. Water Absorption, Coarse Aggregate: ASTM C 127.

2. Water Absorption, Fine Aggregate: ASTM C 128.

C. Reinforcing Steel: ASTM A 615, Grade 60, deformed epoxy coated in accordance with ASTM A 775.

D. Welded Wire Fabric:

1. Plain: ASTM A 185, epoxy coated.

2. Deformed Steel: ASTM A 497, epoxy coated.

3. Fabricated Steel Bar or Rod Mats: ASTM A 184, epoxy coated.

E. Tie Wire: ASTM A 580, Type 316L, cold finished annealed, Huntington Alloy Co. "Monel", "Inconel", or an approved equal.

F. Air Entrainment Admixture: ASTM C 260.

G. Water Reducing or Retarding Admixtures: ASTM C 494, Type C, D, or F/G, with no chloride, bromide, and fluoride ingredients. Use Pozzolith 300-R manufactured by Master Builders, Plastiment manufactured by Sika Chemical Corp., or an approved equal.

H. Silica Fume Slurry Admixture: 45 to 50 percent silica fume, water, and superplasticizer as dispersant. Silica Fume: 85 percent amorphous silicon dioxide in accordance with ASTM C 311; loss on ignition shall not exceed 6 percent and moisture shall not exceed 3 percent in accordance with ASTM C 311. Surface area not less than 10,000 square meters per kilogram at bed porosity of 0.50 in accordance with ASTM C 204.

Reduce water in mix by 5.6 to 9.5 lbs. for each gallon of slurry added to mix, as recommended by slurry Manufacturer used.

Add Owner-approved slurry to concrete mix to achieve 7.5 percent dry silica fume by weight of cement. Mixing procedures as recommended by silica fume slurry manufacturer. Sika "Sikacrete 950"; W.R. Grace "Force 10,000" or approved equal. Submit applicable Owner-approved Research Report with shop drawing submittal.

I. Pigment: Pure mineral type, color-resistant to alkalis, nonfading. Color as required to produce finished concrete matching color and appearance of prebid sample and the 72 inch by 72 inch sample at the Owner's Representative's office.

2.02 SUPPORT DEVICES

Unless otherwise specified on the Plans, the following requirements shall apply:

A. Connecting and Support Devices: ASTM A 666, Type 316L stainless steel.

B. Bolts: ASTM A 193, Grade B8M (Type 316).

C. Nuts and Washers: ASTM A 194, Grade 8M (Type 316).

D. Weld Filler Metal for Stainless Steel: Stainless steel to stainless steel; AWS A5.4, Grade 316L filler metal; stainless steel to carbon steel, AWS A5.4, Grade 309 filler metal, 3/32 inch diameter.

E. Primer: Zinc-dust, zinc oxide primer in a phenolic resin spare varnish vehicle, TT-P-641 Type III (for galvanized surfaces).

2.03 ACCESSORIES

Unless otherwise specified on the Plans, the following requirements shall apply:

A. Plates, Angles, Anchors, and Studs: ASTM A 666, Type 316L stainless steel. Austenitic Steel Castings for Embedments and Anchorage Assemblies: ASTM A 351, Type CF3M, with Type 316 stainless steel bolts, nuts, and washers.

B. Reglets: Plastic, shaped and flanged to remain in place once cast; tape closed to prevent concrete intrusion.

C. Bearing Pads: Neoprene, molded to size or cut from molded sheet, 70-80 Type A durometer, ASTM D 2240.

D. Sealant: Specified in Section 07900 – Sealants and Caulking.

E. Gaskets: ASTM C 509, preformed, firm, cellular, neoprene, sized to be under constant compression at the joints, and manufactured in lengths to minimize field splices.

F. For bridge structures, expansion and fixed joints and bearings shall conform with CSS Section 51-1.12.

2.04 FORMS AND MOLDS

A. Forms: Manufacturer's standard with smooth, hard, dense, and rigid casting surface; without bow, warpage, oil canning, or other imperfections. Comply with PCI MNL 117, Division V, Section 2, Article 5.2.1.

B. Form Release Agent: Manufacturer's standard, nonstaining, nonpetroleum based; compatible with concrete surface sealer.

C. Surface Sealer: Clear, flat, penetrating, nonyellowing, nonclouding solution; high concentration of organosilane in an aqueous alcoholic vehicle which is designed to provide water repellent concrete surfaces from which graffiti can be easily removed. Oil-type silicones, paraffins, waxes, vinyls, modified urethanes, or acrylics shall not be used. Sealant shall be tested by Manufacturer and proved compatible with surface sealer.

D. Molds: Fabricate using steel, concrete, fiberglass, reinforced plastic or wood.

a. Selection of materials for molds shall be at manufacturer's option, except that wood shall not be used without specific prior approval of the Owner’s Representative.

b. Cast elements in molds of rigid construction, accurate in detail with precise corners and arises, and designed to provide close control of dimensions, radii, and details as indicated on the Plans.

c. Prior to casting of precast elements, molds shall have surface joints, radii, and corners filled, ground, filed, straightened, or otherwise removed to provide finished concrete surface that is smooth and dense, free of honeycombing, air pockets, offsets, sinkages, or other irregularities.

d. Mold Release Agents: Synthetic resin or organic compound containing no wax, oil, silicates, or varnish, and compatible with specified coatings, sealants, fresh concrete, curing process, and adhesives.

e. Cast molds with release agents to facilitate removal of elements from molds.

2.05 MIX

Silica Fume Concrete: Minimum 5,000 PSI (unless noted otherwise on the project plans), 28 day compressive strength; aggregate 3/8 inch max; water - 305 lbs per cu yd; cement - 750 lbs per cu yd; w/c ratio 0.40 max; slump range 3 inches to 5 inches with silica fume slurry; air entrainment 4 percent plus or minus 1 percent; 7.5 percent dry silica fume by weight of cement, provided through specified silica fume slurry; add superplasticizer to achieve desired working slump for precast concrete as may be required by silica fume slurry Manufacturer. Add colorant as required to achieve match with Engineer's sample. Moist cure by spray mist.

2.06 FABRICATION

A. General: Precast concrete units shall be fabricated by a licensed shop in accordance with ACI 318, PCI MNL-116 (structural features), PCI MNL-117 (nonstructural features, surface treatments, patching, and tolerances). Plant records and quality control program shall be maintained during production of precast units. Records and access to plant shall be available to the Owner's Representative upon request.

Rigid molds shall be used, constructed to maintain precast unit uniform in shape, size, and finish, free from castings and dents, gouges, oil canning, or other irregularities that will adversely affect appearance or strength of units. Consistent quality shall be maintained during manufacture.

Equipment for handling epoxy-coated reinforcing bars shall have protected contact areas. Bundles of coated bars shall be lifted at multiple pickup points to prevent bar-to-bar abrasion from sags in the bundles. Coated bars or bundles of coated bars shall not be dropped or dragged. Coated bars shall be stored on protective cribbing. The maximum amount of damage shall not exceed 2 percent of the surface area of each bar.

Reinforcing steel, anchors, inserts, plates, angles, and other cast-in-place items shall be embedded as indicated on shop drawings. Reinforcement shall be fabricated and placed in conformance with ACI 318. No tack welding of or to reinforcement permitted. Welding when allowed shall conform to AWS D 1.4 requirements. No carbon steel chairs, spacers, nails or tie wire shall be used in positioning reinforcing and embedments.

Adequate reinforcing steel shall be provided to control cracking. Maximum permissible crack width:

Surfaces exposed to weather: 0.005 inch.

Surfaces exposed to view but not weather: 0.01 inch

Connecting devices, plates, angles, items fit to steel framing members, inserts, bolts, and accessories shall be fabricated to permit initial placement and final attachment.

Anchors, inserts, lifting devices, and other accessories shall be placed and embedded in accordance with approved shop drawings, accurately positioned in their designed location and anchored to prevent dislocation during panel construction. Do not use powder actuated fasteners for surface attachment of accessory items except as specifically approved by the Owner's Representative and specifically accepted by the precast unit manufacturer. Flashing reglets shall be placed and embedded continuous and straight, with lifting devices to permit removal after erection.

Units shall be moist cured with water mist to develop concrete quality and to minimize surface drying and appearance blemishes such as nonuniformity, staining, or surface cracking.

Precast units shall be removed from formwork using procedures conforming to PCI MNL-117. Minor patching in plant acceptable, providing structural adequacy and appearance of units are not impaired. Each precast unit shall be identified with corresponding code on erection drawings, in location not visible to finished work.

Repair of damaged epoxy coating, when required, shall be made with patching material conforming to ASTM A 775. Repair shall be in accordance with the material Manufacturer's recommendations.

B. Fabrication and Tooling of Stainless Steel Connections and Embedments: All tools used during fabrication shall be made of stainless steel. Use of carbon steel tools is prohibited.

Welding of stainless steel shall conform to AWS A 5.4, AWS B 2.1 and AWS D1.1, using tungsten inert gas procedures and 316L filler metal for stainless steel to stainless steel and 309 filler metal for stainless steel to carbon steel. Surfaces shall be sanded smooth (do not grind), and oxidized discoloration removed (blue heat tint). Threaded parts of stainless steel bolts shall be lubricated with graphite suspended in alcohol (Neo-Lube) every time that nut is run on or off the threads. No other lubricant is acceptable.

Erection slings, cables, blocking, hardware and restraints shall be nonmetallic or stainless steel. Cribbing or crating shall be wood.

2.07 FINISH OF PRECAST UNITS

A. Backs and Sides (Unexposed Edges): Smooth, dense, uniform surface free from blemishes. Defects in backs and sides (unexposed edges) shall be repaired as approved.

B. Faces: Appearance, color, and texture finish of all panels shall match appearance, color and texture of the approved sample panels constructed by the Contractor. Panels that do not match shall be rejected. Repairs will be acceptable only if structural adequacy and appearance of product are not impaired and the repair and surrounding area match the approved sample panels at the Owner’s Representative's office.

Mechanical finishing of panels at precast plant shall be at essentially the same age (or strength) of concrete to assure finished appearance is uniform from panel to panel.

To reduce possibility of stains occurring during transportation and erection, sealer shall be applied at the plant as recommended by Manufacturer and the precaster and shall be guaranteed in writing that sealer will not alter or yellow the original precast concrete color in any way and that it is compatible with the joint sealants to be used on the project. Seal finish surfaces of precast units to be exposed in completed Work as follows: apply a uniform coat of surface sealer in accordance with Manufacturer's written instructions. Apply sealer by method and in quantity required to provide coverage specified by sealer Manufacturer. Forty-eight (48) hours after application of sealer, apply water to face of each panel in sufficient quantity to determine if full sealer coverage was achieved. Panels not fully sealed shall be resealed and retested. A second coat shall be applied at the Site after erection and cleanup in accordance with the Manufacturer's instructions.

2.08. PRECAST PRESTRESSED CONCRETE SLAB BRIDGES

Precast prestressed concrete slab bridges shall conform to the provisions in Section 51, “Concrete Structures," of the CSS and these specifications.

Forms for providing the circular voids in the slabs shall be watertight and shall be constructed of an approved material that will resist breakage or deformation during the placement of the concrete

and will not materially increase the dead load of the span. The forms shall be properly supported and tied and shall remain in correct position at all times during the placement of the concrete.

Except where otherwise shown on the Plans, the top surface of the slab shall be given a coarse texture by brooming with a stiff bristled broom or by other suitable devices which will result in uniform transverse scoring, in advance of curing operations. The requirements of the seventh paragraph of Section 51-1.17, "Finishing Bridge Decks," of the CSS shall not apply.

When slab spans with concrete deck are shown on the Plans, the top surfaces shall be cleaned as specified for construction joints in Section 51-1.13, "Bonding," of the CSS. 5. When slab spans with an asphalt concrete overlay are shown on the Plans, the removal of laitance and curing compound from the top surfaces will not be required.

After the concrete slabs are in final position, the anchor dowel holes shall be filled with mortar.

2.09 PRECAST PRESTRESSED CONCRETE BRIDGE MEMBERS

Precast reinforced concrete girders shall conform to the provisions in Section 51, “Concrete Structures," of the CSS.

The top surface of the member shall be given a coarse texture by brooming with a stiff bristled broom or by other suitable devices that will result in uniform transverse scoring, in advance of curing operations. That portion of the top surface of box girders that is to be covered by expanded polystyrene shall be given a wood float finish. Remaining portions of the surface of the girders shall be given the coarse textured finish. The requirements of the seventh paragraph of Section 51-1.17, "Finishing Bridge Decks," of the CSS shall not apply.

When box girders with a concrete deck are shown on the plans, surfaces noted to be given a coarse broom finish shall be cleaned of surface laitance and curing compound before placing deck concrete. Exposure of clean aggregate will not be required.

When Double T girders with concrete deck are shown on the Plans, surfaces noted to be given a coarse broom finish shall be cleaned of surface laitance and curing compound before placing deck concrete. Exposure of clean aggregate will not be required.

2.10 NSF / ANSI STANDARD 61

A. All cementitious material, admixtures, curing compounds, and other industrial produced materials used in concrete, or for curing or repairing of concrete, that can contact potable water or water that will be treated to become potable shall be listed in NSF / ANSI Standard 61.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Examination: The Contractor shall verify that the structure, anchors, devices, and openings are ready to receive Work of this Section. Beginning of installation means acceptance of existing condition.

B. Preparation: The Contractor shall provide for erection procedures and induced loads, during erection, maintain temporary bracing in place until final support is provided, provide necessary hoisting equipment and safety and protective devices.

C. Erection: The units shall be erected in accordance with approved shop/erection drawings without damage to shape or finish or adjacent work. Damaged panels shall be replaced or repaired. Unless otherwise shown, members shall be erected level and plumb within allowable tolerances.

The Contractor shall align and maintain uniform horizontal and vertical joints as erection progresses, provide approved shims and wedges as required, and when members required adjustment beyond design or tolerance criteria, discontinue affected work. Units shall be secured in place and field welds, scratches and otherwise damaged steel surfaces shall be touched up.

Field fabrication and erection of stainless steel shall conform to the procedures outlined in the paragraph entitled "Fabrication and Tooling of Stainless Steel Connectors and Embedments."

The vertical units shall be set dry, without grout, attaining joint dimension with lead or plastic shims and spacers.

Pickup points, boxouts, inserts, bearing surfaces, and open spaces at connections and joints shown shall be grouted with non-shrink grout system(s) recommended by the manufacturer of the precast units, in accordance with Section 03315 - Grout. The color and texture of concrete surfaces of adjacent areas shall be finished to match in the same plane. Provide forms or other acceptable method to retain the grout in place until it is sufficiently hard to support itself. Pack spaces with stiff grout material, tamping voids completely full. Place the grout in a manner to finish smooth, plumb, and level with adjacent concrete surfaces. Keep grouted surfaces damp for not less than 24 hours after grout has taken its initial set. Promptly remove grout material from exposed surfaces before its hardens.

D. Tolerances: In accordance with requirements of PCI MNL-117 unless otherwise indicated.

1. Variation from Plane of Location: ¼ inch in 10 feet and 3/8 inch in 100 feet maximum, compensating not cumulative.

2. Offset from True Alignment between Two Connecting Members: ¼ inch maximum.

3. Out of Square: 1/8 inch in 10 feet maximum, noncumulative.

4. Variation in Dimensions Indicated in Shop Drawings: Plus or minus 1/8 inch.

5. Misalignment of Anchors, Inserts, Openings: 1/8 inch, maximum.

6. Bowing or Warpage of Units: 1/700 of panel dimension.

7. Exposed Joint Dimension: ¾ inch plus or minus 1/8 inch.

8. Location of Reglets: ¼ inch from true position.

E. Joint Sealing: Specified in Section 07900 – Sealants and Caulking.

3.02 CLEANING

A. No sooner than 72 hours after joints are sealed, faces and other exposed surfaces of precast units shall be cleaned using a cleaning detergent recommended by the sealer manufacturer and water applied with a soft bristle brush, and thoroughly rinsed using clean water or other approved procedures.

B. Units shall be cleaned when temperature and humidity conditions are such that surfaces dry rapidly (e.g., 70°*F* and rising, 50 percent Relative Humidity or less).

C. Discolorations which cannot be removed by these procedures shall be considered defective work, and repaired or replaced as directed by the Owner's Representative.

D. Just before final acceptance by the Owner's Representative, clean precast units to remove dirt and stains.

3.03 PROTECTION

Adjacent surfaces shall be protected from damage during sealing and cleaning operations and against damage, disfiguration or discoloration from subsequent operations. Noncombustible shielding shall be used during welding operations.

3.04 PRECAST PRESTRESSED CONCRETE SLAB BRIDGES

Transverse connections for precast deck units shall conform to the following requirements:

A. After the deck units are in final position, the anchor bars shall be mortared in and the mortar between the ends and in the keyways between the members shall be placed.

B. No equipment or other loads shall be allowed on spans that have mortar between the deck units or in the anchor bar holes that has been in place less than 72 hours.

C. Deck shear connector rods, shown as tie rods on the Plans, shall conform to the following:

1. Bolts, rods, nuts, and plate or beveled washers shall be structural steel; lock washers shall be ANSI heavy duty spring washers; and all metal shall be hot-dip galvanized after fabrication in conformance with the provisions in Section 75-1.05, "Galvanizing," of the CSS.

2. Openings for transverse connections shall be accurately placed and shall conform to the details shown on the Plans.

3. Nuts shall be tightened to a snug fit after the deck units are positioned and prior to placing mortar in the keyways.

4. Nuts shall be tightened after the mortar in the keyways between the units has been in place at least 24 hours. Threads at the ends of bolts or rods shall be burred to prevent loosening of the nut.

5. Where the ends of transverse rods will be exposed, the nuts and ends of rods shall be recessed so that all metal will be at least 1" inside the surface of the member. After the nuts have been tightened, the recess shall be filled with mortar.

3.05 PRECAST PRESTRESSED CONCRETE BRIDGE MEMBERS

Temporary lateral bracing shall be provided for precast girders. The bracing shall be installed at each end of each girder, except notched ends, prior to the release of the erection equipment from the girder and shall remain in place until 2 days after the concrete diaphragms have been placed. The bracing shall be adequate to prevent overturning of the girders prior to completion of the Work and as a minimum shall be capable of resisting a lateral force of 15 PSF of girder side area applied laterally in either direction to the top of the girder. Girder erection shall not be started until the temporary lateral bracing proposed for use by the Contractor has been approved by the Owner's Representative.

Keyways shall be filled with Class 1 concrete, conforming with CSS Section 90-1, produced from aggregate with a 1 inch, maximum grading. The penetration of the concrete shall be near the lower limit of the specified nominal penetration. Keyways shall be mortar-tight before placing concrete. The concrete shall be thoroughly consolidated.

No equipment or other loads will be allowed on spans until at least 72 hours after the last mortar has been placed in the anchor dowel holes or the last concrete has been placed in the keyways.

Deck shear connector rods, shown as tie rods on the Plans, shall conform to the following:

A. Bolts, rods, nuts and plate or beveled washers shall be structural steel; lock washers shall be ANSI heavy duty spring washers; and all metal shall be hot-dip galvanized after fabrication in conformance with the provisions in Section 75-1.05, "Galvanizing," of the CSS.

B. Openings for transverse connections shall be accurately placed and shall conform to the details shown on the Plans.

C. Nuts shall be tightened to a snug fit after the deck units are positioned and prior to placing mortar in keyways.

D. Nuts shall be tightened after the mortar in the keyways between the units has been in place at least 24 hours. Threads at the ends of bolts or rods shall be burred to prevent loosening of the nut.

E. Where the ends of transverse rods will be exposed, the nuts and ends of rods shall be recessed so that all metal will be at least 1" inside the surface of the member. After the nuts have been tightened, the recess shall be filled with mortar.

The anticipated deflection and method to accommodate deflection of precast prestressed concrete girders, prior to the time the deck concrete is placed, shall be shown on the Plans in conformance with the provisions in General Requirements. The deflection shall include the following:

i. Anticipated upward deflection caused by the prestressing forces.

ii. Downward deflection caused by the dead load of the girder.

iii. Deflection caused by the creep and shrinkage of the concrete for the time interval between the stressing of the girders and the planned placement of the deck.

Such deflection shall be substantiated by calculations that consider the ages of the girder concrete at the time of stressing and the Contractor's planned placement of the deck. All deflection calculations shall be based on the concrete producer's estimate of the modulus of elasticity at the applicable concrete age.

Adjustments to accommodate girder deflections, which occur prior to the time the deck concrete is placed, may include revisions in bearing seat elevations, but any such adjustments shall be limited by the following conditions:

A. The minimum permanent vertical clearance under the structure as shown on the Plans shall not be reduced.

B. The profile grade and cross slope of the deck shall not be changed.

C. A minimum of 1 inch of deck slab concrete between the top of the precast girders and the deck slab reinforcement shall be maintained.

D. A minimum of 1 inch of deck slab concrete between the top of the expanded polystyrene in the area between the girder webs and the deck slab reinforcement shall be maintained.

Girders with unanticipated girder deflection and which cannot comply with conditions A, B, and C will be rejected in conformance with the provisions in General Requirements.

Adjustments to accommodate girder deflections will not be considered a change in dimensions. Full compensation for increases in the cost of construction, including increases in the quantity of deck or bearing seat concrete, resulting from adjustments to accommodate girder deflections shall be considered as included in the Contract price paid for the various items of work involved and no additional compensation will be allowed therefore.

END OF SECTION 03400

SECTION 05120- STRUCTURAL STEEL

PART 1 - GENERAL

1.01 DESCRIPTION

A. The Contractor shall provide structural steel beams, columns, bracings, galvanizing, and appurtenances, complete, in accordance with the Contract Documents.

1.02 RELATED SECTIONS

A. The Work of the following Sections apply to the Work of this Section. Other Sections, not referenced below, shall also apply to the extent required for proper performance of the Work.

B. Related Work Specified in Other Sections:

1. Section 03200 - Reinforcement Steel.

2. Steel supports, hangars, brackets and other miscellaneous items accessory to the mechanical and electrical installations.

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. The current edition of the Uniform Building Code (UBC) of International Conference of Building Officials (ICBO).

B. Commercial Standards (Current Edition):

1.	AISC M 011	Manual of Steel Construction for Shop and Field Welding.
2.	AISC S 326	Design, Fabrication and Erection of Structural Steel for Buildings.
3.	AWS B 3.0	Welding Procedures and Performance Qualifications.
4.	AWS D 1.1	Structural Welding Code - Steel.
5.	AWS W 1	Welding Metallurgy

C. ASTM Standards in Building Code (Current Edition):

1.	ASTM A 6	General Requirements for Rolled Steel Plates, Shapes, Sheet Piling, and Bars for Structural Use
2.	ASTM A 36	Structural Steel (Except "W" rolled shapes)
3.	ASTM A 283	Low and Intermediate Tensile Strength Carbon Steel Plates, Shapes and Bars
4.	ASTM A 325	High Strength Bolts for Structural Steel Joints
5.	ASTM A 490	Heat-Treated Structural Steel Bolts
6.	ASTM A 992	High Strength Structural Steel ("W" rolled shapes)
7.	ASTM A 500	Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes

1.04 CONTRACTOR SUBMITTALS

A. The Contractor shall furnish submittals to the Engineer for review in accordance with the Specification Section 01300 – Contractor Submittals.

B. Shop Drawings and Erection Drawings: The shop drawings shall provide a materials and specification list, construction and fabrication details, layout and erect diagrams, and the method of anchorage to adjacent construction. The shop drawings shall give the location, type, size and extent of welding and bolted connections, and clearly distinguish between shop and field connections. Before submittal of the shop drawings, the Contractor shall coordinate the shop drawings and related trades to ensure proper mating of assemblies. All work shall conform to the approved shop drawings.

C. Test Reports: The Contractor shall furnish certified physical and chemical mill test reports for material used for structural members. All tests shall be performed in accordance with applicable ASTM Standards.

1.05 DELIVERY

A. The Fabricator shall deliver the fabricated material to the job site in the sequence as approved by the Engineer.

B. All shipped material to be piece-marked for erection with metal tags or other appropriate method approved by the Engineer.

C. All material shipments shall include sufficient bolts for erection, plus at least the following extra bolts:

1. Add a minimum of 5% for unfinished bolts.

D. The Engineer reserves the right to inspect fabricated material at Fabricator's shop. The Engineer's expenses for shop inspections shall be borne by the Contractor. In the event the Engineer identifies faulty materials or workmanship in fabricated material at the Fabricator's shop, the materials shall be re-fabricated at no cost to the Owner. The Engineer shall be notified at least 7 days before the shipment of material. Shipments of material shall not be delayed if the Engineer does not require inspection.

E. Material damaged in shipment shall be replaced or repaired at the Contractor's expense at no additional cost to the Owner.

1.06 QUALITY ASSURANCE

A. The Contractor shall fabricate and erect structural steel work in accordance with the latest edition of AISC "Specification for the Design, Fabrication and Erection of Steel for Buildings", and "Code of Standard Practice for Steel Buildings and Bridges", except whenever there is a discrepancy between the Plans and this Section, the Plans will govern.

B. Continuous Inspections:

1. The Contractor shall perform all welding and high strength bolting of structural steel assemblies under continuous inspection of the Engineer. Should such fabrication be performed in the shop of a licensed Fabricator approved by the Engineer, only the field welding and high strength bolting of structural steel assemblies will be required to be performed under continuous inspection of the Engineer.

2. The Contractor shall notify the Engineer at least 48 hours in advance of the needed inspection.

3. The Contractor shall provide copies of inspection reports to the Engineer and Building Department, if applicable.

1.07 WARRANTY

A. The Fabricator shall furnish a warranty to the Owner to replace or repair all defective material and workmanship within 18 months of shipment, or 12 months of plant startup, whichever occurs first, excluding defects due to normal usage.

PART 2 - PRODUCTS

2.01 MATERIALS

A. General: All materials shall be new, sound and conform to the requirements herein. Unless otherwise indicated, structural steel shall be coated per Technical Specification - Division 9 requirements.

B. Structural Steel: Rolled shapes, plates and bars shall conform to the latest edition of the AISC "Manual of Steel Construction", and shall also conform to current ASTM Designation A 36. All "W" rolled shapes shall conform to A 992.

C. Pipe: Pipe shall conform to ASTM A 53, Grade B seamless galvanized as required, Schedule 40, except as otherwise shown on the Plans.

D. Tubes: Tubes shall conform to ASTM A 500 Grade B.

E. Welding Electrodes: The Contractor shall use steel electrodes conforming with AWS D 1.1, except that E7024 rods or electrodes shall not be used.

2.02 FABRICATION

A. Fabrication shall be in accordance with AISC S 326 and indicated requirements. All structural steel welding in off-site fabrication shops shall be continuously inspected by the Engineer with the inspection cost of the Engineer to be borne by the Contractor. The continuous inspection will be waived if the work is done in a shop certified by the Council of American Building Officials (CABO), or listed by the International Conference of Building Officials (ICBO) Evaluation Services, Inc.

PART 3 - EXECUTION

3.01 INSTALLATION

A. General:

1. Structural assemblies and shop and field welding shall meet the requirements of AISC M 011 and AISC S 326.

2. Measurements and dimensions shall be verified by the Contractor at the site.

3. Bolt holes shall be 1/16 inch larger than the nominal size of bolts. Where thick metals are indicated, holes shall be sub-punched and drilled, or reamed.

4. Dissimilar metals shall be protected from galvanic corrosion by means of pressure tapes, coatings or isolators.

5. Bolts shall not be permitted to drift, and holes shall not be enlarged to correct misalignment. In the event of mismatching of holes, new materials shall be provided.

6. Structural steel completely encased in concrete shall not be galvanized or painted, and shall have a clean surface for bonding to concrete.

7. Damaged structural steel shall be replaced. Use of salvaged, reprocessed, or scrap materials shall not be permitted.

B. Welding: Welding shall be performed by operators who have been qualified by tests as prescribed by AWS-W1 Section 7, to perform the type of welding indicated. Welding shall comply with AWS Code for Arc Welding in Building Construction, Section 4, Workmanship. Electrodes shall be matching per AWS.

C. Coating: The Contractor shall coat structural steel in accordance with Technical Specification - Division 9 requirements.

3.02 INSPECTION

A. The Engineer reserves the right to inspect all materials and workmanship covered in this Specification. However, such inspection shall not relieve the Contractor of his responsibility to furnish materials and workmanship in accordance with the Contract requirements. If inspection indicates a

weld or part of the material is defective, the Contractor shall remove and replace it at the Contractor's expense.

B. Shop inspection may include, but not be limited to, the following:

1. Verification of conformance of materials with this Specification and the Plans. The limits of acceptability and repair of surface imperfections for structural steel shall be in accordance with ASTM A 6.

2. Visual and dimensional inspection of shop-fabricated structural steel members and assemblies shall be in conformance with this Specification and the Plans.

3. Verification of welding procedures, welding operations and welder and tacker certificates of qualification shall be in accordance with this Specification and AWS D 1.1.

END OF SECTION 05120

SECTION 05220 - CONCRETE BOLTS

PART 1 - GENERAL

1.01 DESCRIPTION

A. The Contractor shall provide concrete anchor bolts, inserts, complete, in accordance with the Contract Documents. Principal items are anchor bolts placed in concrete, adhesive anchors, expansion bolts, and drilled anchors.

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Except as otherwise indicated in this Section of the Specifications, the Contractor shall comply with the latest adopted edition of the Standard Specifications for Public Works Construction (SSPWC), together with the latest adopted editions of the Regional Amendments.

B. The current edition of the Uniform Building Code (UBC) of International Conference of Building Officials (ICBO).

C. Federal Specifications:

1.	MIL-A-907E	Antiseize Thread Compound, High Temperature

D. Commercial Standards (Current Edition):

1.	American Welding Society AWS A 5 Series.	
2.	ANSI/AWS B 3.0	Welding Procedure and Performance Qualifications
3.	ANSI/AWS D 1.1	Specification for Welding Code - Steel
4.	ANSI/AWS D 1.3	Specification for Welding Sheet Steel in Structure
5.	AISC	American Institute of Steel Construction - Manual of Steel Construction

E. ASTM Standards in Building Codes (Current Edition):

1.	ASTM A 36	Specification for Structural Steel
2.	ASTM A 123	Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
3.	ASTM A 153	Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
4.	ASTM A 193	Specifications for Alloy-Steel and Stainless Steel Bolting Materials for High Temperature Service
5.	ASTM A 194	Specifications for Carbon and Alloy Steel Nuts for Bolts and High Pressure and High Temperature Service
6.	ASTM A 307	Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile

7.	ASTM A 320	Specification for Alloy Steel Bolting Materials for Low-Temperature Service
8.	ASTM A 563	Specification for Carbon and Alloy Steel Nuts

1.04 CONTRACTOR SUBMITTALS

A. Shop Drawings: Shop drawings of all concrete bolts shall be submitted to the Owner's Representative for review in accordance with the Specification Section 01330 – Submittals/Shop Drawings.

B. An International Conference of Building Officials (ICBO) report listing the ultimate load capacity in tension and shear for each size and type of adhesive and expansion concrete anchor used shall be submitted for review. The Contractor shall submit manufacturer's recommended installation instructions and procedures for all adhesive and expansion anchors for review and approval. The Contractor shall follow approved procedures during installation of concrete anchors.

C. No substitution for the indicated adhesive anchors will be considered unless accompanied with ICBO report verifying strength and material equivalency, including temperature at which load capacity is reduced to 90 percent of that determined at 75°*F*.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS

A. Anchor Bolts: Anchor bolts shall be fabricated of materials complying with SSPWC Subsections 206-1.4.1 and 209-2.2, and as follows:

1. Steel bolts: ASTM A 307 Grade A.

2. Fabricated steel bolts: ASTM A 36.

3. Stainless steel bolts, nuts, washers: ASTM A 320, Type 316.

B. Standard Service Bolts (not Buried or Submerged): Except where otherwise indicated, all bolts, anchor bolts, and nuts shall be steel, galvanized after fabrication as indicated herein unless the bolts are for pipe fittings, transition couplings, mechanical restrained joint fittings, flanged coupling adapters or other piping or piping fittings. The bolts and hardware for these items are specified in Section 02650. Threads on galvanized bolts and nuts shall be formed with suitable taps and dies such that they retain their normal clearance after hot-dip galvanizing. Except as otherwise indicated, steel for bolts, anchor bolts and cap screws shall be in accordance with the requirements of ASTM A 307, Grade A or B, or threaded parts of ASTM A 36.

C. Buried or Submerged Bolts: Unless other corrosion-resistant bolts are indicated, all bolts, anchor bolts, nuts and washers which are buried, submerged, or below the top of the wall inside any hydraulic structure shall be Type 316 stainless steel conforming to ASTM A 193 for bolts, and to ASTM A 194 for nuts, unless the bolts are for pipe fittings, transition couplings, mechanical restrained joint fittings, flanged coupling adapters or other piping or piping fittings. The bolts and hardware for these items are specified in Section 02650. All threads on stainless steel bolts shall be protected with an antiseize lubricant suitable for submerged stainless steel bolts, to meet government specification MIL-A-907E.

1, Antiseize lubricant shall be classified as acceptable for potable water use.

2. Antiseize lubricant shall be "PURE WHITE" by Anti-Seize Technology, Franklin Park, IL, 60131; AS-470 by Dixon Ticonderoga Company, Lakehurst, NJ, 08733, or equal.

D. Bolt Requirements:

1, The bolt and nut material shall be free-cutting steel.

2. The nuts shall be capable of developing the full strength of the bolts. Threads shall be Coarse Thread Series conforming to the requirements of the American Standard for Screw Threads. All bolts and cap screws shall have hexagon heads, and nuts shall be Heavy Hexagon Series.

3. The length of all bolts shall be such that after joints are made up, each bolt shall extend through the entire nut, but in no case, more than ½ inch beyond the nut.

E. Adhesive Anchors: Unless otherwise indicated, all drilled, concrete or masonry anchors shall be adhesive anchors. No substitutions will be considered unless accompanied with ICBO report verifying strength and material equivalency.

1, Epoxy adhesive anchors are required for drilled anchors where exposed to weather, in submerged, wet, splash, overhead, and corrosive conditions, and for anchoring handrails, pumps, mechanical equipment, and reinforcing bars. Epoxy anchor grout shall comply with Section 03315 - Grout. Threaded rod shall be stainless steel Type 316.

2. Unless otherwise indicated, glass capsule, polyester resin adhesive anchors will be permitted in locations not indicated above, and shall be Hilti HVA, or equal. Threaded rod shall be galvanized steel.

F. Expanding-Type Anchors: Expanding-type anchors, if indicated or permitted, shall be steel expansion-type ITW Ramset/Redhead "Trubolt" anchors; McCullock Industries "Kwick-Bolt"; or equal. Lead caulking anchors will not be permitted. Size shall be as indicated. Expansion-type anchors, which are to be embedded in grout, may be steel. Nonembedded buried, or submerged anchors shall be stainless steel.

G. Powder-Driven Pins: Powder-driven pins for installation in concrete shall be heat-treated steel alloy. If the pins are not inherently sufficiently corrosion-resistant for the conditions to which they are to be exposed, they shall be protected in an acceptable manner. Pins shall have capped or threaded-heads capable of transmitting the loads the shanks are required to support.

H. Impact Anchor: Impact anchors shall be an expansion-type anchor in which a nail-type pin is driven to produce the expansive force. It shall have a zinc sleeve with a mushroom-style head and stainless steel nail pin. Anchors shall be Metal Hit Anchors, manufactured by Hilti, Inc.; Rawl Zamac Nailin, manufactured by the Rawlplug Company, or equal.

2.02 GALVANIZING

A. Iron and Steel: ASTM A 123, with average weight per square foot of 2.0 ounces, and not less than 1.8 ounces per square foot.

B. Ferrous Metal Hardware Items: ASTM A 153 with average coating weight of 1.3 ounces per square foot.

C. Touch-Up Material For Galvanized Coatings: Repair galvanized coatings marred or damaged during erection or fabrication by use of DRYGALV, as manufactured by the American Solder and Flux Company, Galvalloy, Galvion, Rust-Oleum 7085 Cold Galvanizing Compound, or equal, applied in accordance with the manufacturer's instructions.

2.03 WELDING ELECTRODES

A. Steel Electrodes: Use welding electrodes conforming with AWS D 1.1, except E7024 rods or electrodes shall not be used.

B. Aluminum Electrodes: Contingent upon alloys being welded, use only inert gas-shielded arc or resistant-welding process with filler alloys conforming to UBC Standard No. 28, Table 28-1-C. Use no process requiring a welding flux.

C. Stainless Steel Electrodes: Perform welding of stainless steel with electrodes and techniques as contained in pertinent AWS A5 series specification, and as recommended in Welded Austenitic Chromium-Nickel Stainless Steel Techniques and Properties as published by the International Nickel Company, Inc., New York, New York.

PART 3 - EXECUTION

3.01 FABRICATION AND INSTALLATION REQUIREMENTS

A. Fabrication and Installation: Except as otherwise indicated, the fabrication and installation of anchor bolts shall conform to the requirements of the American Institute of Steel Construction "Manual of Steel Construction".

B. Install adhesive expansion and drilled anchor bolts in accordance with method specified in ICBO for manufacturer product.

C. Powder-Driven Pins: Powder-driven pins shall be installed by a craftsman who is certified by the manufacturer as being qualified to install the manufacturer's pins. Pins shall be driven in one initial movement by an instantaneous force that has been carefully selected to attain the required penetration. Driven pins shall conform to the following requirements where "D" = Pin's shank diameter:

Material Penetrated by Pin	Material's Minimum Thickness	Pin's Shank Penetration in Supporting Material	Minimum Space From Pin's CL to Edge of Penetrated Material	Minimum Pin Spacing
Concrete	16D	6D minimum	14D	20D

3.02 WELDING

A. Perform all welding in accordance with the "Structural Welding Code-Steel", AWS D 1.1, and current revisions. Use only welders qualified by tests in accordance with AWS B 3.0.

3.03 GALVANIZING

A. Bolts, anchor bolts, nuts and similar threaded fasteners, after being properly cleaned, shall be galvanized in accordance with the requirements of ASTM A 153. Field repairs to galvanizing shall be made using "Galvinox", "Galvo-Weld", or equal.

3.04 INSPECTION

A. The Owner's Representative reserves the right to inspect all materials and workmanship covered in this Section. Such inspections will not relieve the Contractor's responsibility to furnish materials and workmanship in accordance with the Specifications. If inspections indicate that materials or workmanship are defective, the Contractor shall remove and replace the defective work at no additional cost to the Owner.

END OF SECTION 05220

SECTION 05650 - PRE-ENGINEERED SHADE STRUCTURE

PART 1 - GENERAL

1.01 DESCRIPTION

A. Install Pre-Engineered Shade Structure per dimensions and type illustrated in the Plans.

B. PRODUCT DESIGN LOADS: To meet governing Building Department requirements. Soil loading and seismic design criteria to be obtained from project specific Geotechnical Report. Minimal Building Department requirements shall be used when no specific Geotechnical Report is provided.

C. DESIGN METHOD: Per applicable building code. Note: Manufacturer to use three-dimensional structural analysis to determine member load and forces.

D. The pre-engineered package shall be a pre-cut and pre-fabricated package that shall include powder coated structural frame members, roof material, fasteners, and trim as well as the installation instructions. The structure shall be shipped knocked down for minimum shipping charges. Field labor will be kept to a minimum by pre-manufactured parts. No onsite welding will be permitted. Connection bolts shall be concealed within the tubing where possible.

E. Where possible, tube column to concrete base will be surface mounted with all anchor bolts hidden within the column.

F. Where possible, the structure will have a moment connection at the top of the column and a pinned connection at the base of the column to ensure a clean connection at the base, reduce the size of the concrete base, and provide for one-step concrete installation process.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 03300 – Cast-In-Place Concrete

1.03 REFERENCES

A. American Institute of Steel Construction (AISC)

B. American Iron and Steel Institute (AISI) Specifications for Cold Formed Members.

C. American Society of Testing and Materials (ASTM)

D. American Society for Quality (ASQ)

E. American Welding Society (AWS)

F. California Building Code (CBC)

G. International Building Code (IBC)

H. Leadership in Energy and Environmental Design (LEED)

I. Lightning Protection Institute (LPI)

J. National Fire Protection Association (NFPA)

K. OSHA Steel Erection Standard 29 CFR 1926 Subpart R-Steel Erection

L. Steel Structures Painting Council (SSPC) SSPC-SP10 Near White Blast Cleaning

1.04 SUBMITTALS

A. Submit 3 set shop drawings and 2 sets structural calculations wet signed and sealed by a Professional Engineer licensed in the State of California.

1.05 QUALITY ASSURANCE:

Provide evidence of commitment of quality craftsmanship as demonstrated by the following:

A. SUPPLIER QUALIFICATIONS:

1. The product shall be designed, produced, and finished at a facility owned and directly supervised by the supplier who has at a minimum of ten years under same ownership making steel frame pre-manufactured structures. Cumulative experience in fabrication will not be an acceptable alternative.

2. The product shall be shipped from a single source.

3. Membership in American Institute of Steel Construction.

4. Membership for American Society of Quality.

5. Membership in American Welding Society.

6. Membership in Chemical Coaters Association International.

7. Membership in Construction Specifications Institute.

8. Full time on-staff Licensed Engineer.

9. Full time on-staff Quality Assurance Manager.

10. Published Quality Management System.

11. Full time on-staff AWS Certified Welding Inspector.

12. Continued certification by an independent inspection agency.

13. Control of finishing quality by in-house shot blast, pretreatment, primer and powder coating.

1.06 PRODUCT STORAGE AND HANDLING

A. Comply with the requirements of Section 01600 – Materials and Equipment.

1.07 WARRANTY

A. Supply manufacturer’s standard 10 year limited warranty on frame and 10 years limited warranty on paint system.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURER

A. USA SHADE & Fabric Structures,
Ph: 800-966-5005
www.usa-shade.com

B. Pre-Fab Builders
1364 East Valencia Drive
714-575-9265
www.prefabinc.org

C. Substitutions must be approved a minimum of ten (10) days before bid. All approved manufacturers shall be notified in writing before the bid date and shall not be allowed to bid without written notification.

D. Alternate suppliers must meet the qualifications and provide proof of certifications listed.

E. Alternate suppliers must provide equivalency to paint system.

F. Alternate suppliers must provide proof that their designs do not infringe on patents or copyrights.

2.02 MATERIALS

A. STRUCTURAL FRAMING: structural steel tube minimum ASTM A500 grade B, "I" beams; tapered columns, open channels, or wood products shall not be accepted for primary beams.

B. COMPRESSION RING: structural channel or welded plate minimum ASTM A36 or COMPRESSION TUBE: structural steel tube minimum ASTM A500 grade B.

C. STRUCTURAL FASTENERS: ASTM A325 high strength bolts and A563 high strength nuts, ASTM A307 anchor bolts.

G. "R" PANEL/MULTI-RIB METAL ROOFING: Multi-rib roofing shall be 24 gauge ribbed galvalume steel sheets with ribs 1 3/16" high and 12" on center. Roof surface shall be painted with Kynar 500 to the manufacturer's standard color. Ceiling surface shall be white. Roof panels are factory precut to size and angle to provide one-step installation.

1. Metal roofing trim shall match the color of the roof and shall be factory made of 26 gauge Kynar 500 painted steel. Trim shall includes panel ridge caps, eave trim, splice channels, roof peak cap, and corner trim as applicable for model selected., reference drawings for additional information. Painted screws and butyl tape are included.

2. Ridge Caps shall be performed with a single central bend to match the roof pitch and shall be hemmed on the sides.

2.03 ACCESSORIES / OPTIONAL

A. ELECTRICAL ACCESS AND BOX CUTOUTS: Electrical access to be provided per manufacturer's electrical access sheet. Electrical cut outs shall be marked as height above finish floor and size of cutout required.

B. Electrical access at compression shall be provided.

C. Electrical access up through columns to be provided.

2.04 FABRICATION

A. All steel fabrication of tubes and plates shall be factory controlled under a documented Quality Management System. All parts shall be permanently etched with identification numbers. Fabrication facility will be experienced for a minimum of ten years in precision tube and plate fabrication. Cumulative experience in fabrication will not be an acceptable alternative.

B. Certified AWS welders, shall make all welded connections in accordance with AWS Specifications and trained by an AWS Certified Welding Inspector.

2.05 FINISH STEEL

A. For quality control purposes, steel shall be cleaned, pretreated and finished at a facility owned and directly supervised by the manufacturer. Steel shall be shot blasted to SSPC-SP10 near-white blast cleaning. SSPC-SP2 hand tool cleaning will not be an acceptable alternative. Parts shall be pretreated in a 3 stage iron phosphate or equal washer. Epoxy primer powder coat to be applied to parts for superior corrosion protection. Top powder coat of Super Durable TGIC Powder Coat to color selected from manufacturer's standard color chart. For environmental purposes, finish shall allow no VOC emissions. Sample production parts shall have been tested and meet the following criteria:

1. Salt spray resistance per ASTM B 117/ ASTM D 1654 to 5000 hours with no creep from scribe line and rating of 10.

2. Humidity resistance per ASTM D2247-02 to 3000 hours with no loss adhesion or blistering.

3. Color/UV resistance per ASTM G154-04 to 2000 hours exposure, alternate cycles with results of (a) no chalking (b) 75% color retention (c) Color variation maximum 3.0 E variation CIE formula (before and after 2000 hours exposure).

PART 3 - ERECTION

A. Footings: The structure shall be set on prepared footings designed by the Shade Structure Manufacturer. Anchor bolts shall also be provided by Shade Structure Manufacturer. Concrete slab (if required) is to be provided by others.

B. The contractor must use appropriate construction practices for the specific site conditions.

C. Install all components according to manufacturer's installation instructions and these specifications.

END OF SECTION 05650

SECTION 07900 - SEALANTS AND CAULKING

PART 1 - GENERAL

1.01 DESCRIPTION

A. The Contractor shall provide caulking, sealing, moisture protection, and appurtenant Work for sealing joints in non-water-bearing surfaces, complete and in accordance with the Contract Documents.

1.02 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Except as otherwise indicated in this Section of the Specifications, the Contractor shall comply with the latest adopted edition of the Standard Specifications for Public Works Construction (SSPWC), together with the latest adopted editions of the Regional Amendments.

B. The current edition of the Uniform Building Code (UBC) of International Conference of Building Officials (ICBO).

C. Except as otherwise indicated, the current editions of the following apply to the Work of this Section:

1. Federal Specifications:

TT-S-001543A	Sealing Compound, Silicone Rubber Base, (For Caulking, Sealing and Glazing in Buildings and Other Structures)
A-A-1556	Sealing Compound, Elastomeric Type, Single Component (For Caulking, Sealing, and Glazing in Buildings and Other Structures)
TT-S-00227E (3)	Sealing Compound, Elastomeric Type, Multi-Component (For Caulking, Sealing and Glazing in Buildings and Other Structures)
SS-S-200E (2)	Sealant, Joint, Two Component, Cold Applied, for Portland Cement Pavement

2. ASTM Standards in Building Codes:

ASTM C 557	Specification for Adhesives for Fastening Gypsum Wallboard to Wood Framing
ASTM C 834	Specification for Latex Sealing Compounds
ASTM C 919	Practice for Use of Sealants in Acoustical Applications
ASTM C 920	Specification for Elastomeric Joint Sealants
ASTM D 41	Specification for Asphalt Primer Used in Roofing, Dampproofing, and Waterproofing

ASTM D 226	Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing
ASTM D 312	Specification for Asphalt Used in Roofing
ASTM D 1752	Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction

D. Manufacturer's Standards: In addition to the standards listed above, the sealants and caulking products and their application shall be in accordance with the manufacturer's published recommendations and specifications.

1.03 CONTRACTOR SUBMITTALS

A. The Contractor shall provide submittals in accordance with the Specification Section 01330 – Submittals/Shop Drawings.

B. Samples: The Contractor shall submit samples (including color samples) of all the caulking and sealant materials and other moisture protection materials proposed for use on the Work. The samples shall be clearly marked with the manufacturer's name and product identification.

C. Technical Data: The Contractor shall submit a complete materials list along with the manufacturer's technical data and literature, specifications, joint width and depth tables, and installation instructions.

D. Certificates: The Contractor shall submit, if requested by the Owner's Representative, certificates from an independent testing laboratory approved by the Owner's Representative, certifying that the submitted materials meet all the requirements of the ASTM and Federal Specifications cited.

E. Warranty: The Contractor shall provide a 5 year written warranty of the entire sealant installation against faulty and/or incompatible materials and workmanship, together with a statement that it agrees to repair or replace, to the satisfaction of the Owner Representative, at no additional cost to the Owner, any such defective areas which become evident within said 5 year warranty period.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery of Materials: Manufactured materials shall be delivered in original, unbroken packages or containers bearing the manufacturer's label. Packages or containers shall be delivered to the site with seals unbroken.

B. Shelf Life: Materials whose shelf life dates have expired shall not be used in the Work. Such materials shall be promptly removed from the project site.

C. Storage: All materials shall be carefully stored in accordance with the manufacturer's instructions, in an area that is protected from deleterious elements, and in a manner that will prevent damage to the product.

PART 2 - PRODUCTS

2.01 SEALANTS AND CAULKING MATERIALS

A. Caulking and sealing materials shall conform to the following requirements:

1. Significant Movement Sealants (+25% Movement Capability):

a) Expansion wall joints; control joints; interior and nontraffic horizontal joints:

1) Two-component, nonsag, polyurethane or polysulfide sealant conforming to Federal Specification TT-S-00227E (3), Class A, Type II, and ASTM C 920; Type M; Class 25; Grade NS.

(a) Products Research & Chemical Corp. ARC-2.

(b) Progress Unlimited "Iso-Flex 2000"; or approved equal.

2) One component, nonsag, low modulus, polyurethane or polysulfide sealant conforming to Federal Specification A-A-1556, Class A, Type II, and ASTM C 920; Type S; Class 25; Grade NS.

(a) Products Research & Chemical Corp., "RC-1".

(b) Tremco "Dymonic"; or approved equal.

3) One component, nonsag, medium modulus, neutral cure, silicone sealant conforming to Federal Specification TT-S-001543A, Class A, and ASTM C 920; Type S; Class 25; Grade NS.

(a) Products Research & Chemical Corp. "PRC-4000".

(b) Dow Corning "795"; or approved equal.

b) Horizontal Joints:

1) Two component, self-leveling, polyurethane or polysulfide sealant conforming to Federal Specification TT-S-00227E(3), Class A, Type I, and ASTM C 920; Type M; Class 25; Grade P.

(a) Products Research & Chemical Corp. "RC-2SL".

(b) Bostic "Chem-Calk 550"; or approved equal.

2) One component, self-leveling, polyurethane or polysulfide sealant conforming to Federal Specification A-A-1556, Class A, Type I, and ASTM C 920; Type S; Class 25; Grade P.

(a) Products Research & Chemical Corp. "6006".

(b) Mameco "Vulkem 45"; or approved equal.

PART 3 - EXECUTION

3.01 INSTALLATION REQUIREMENTS

A. Manufacturer's Recommendations: All work under this Section and all testing, where applicable, shall be performed in accordance with manufacturer's printed recommendations, specifications, and installation instructions except where more stringent requirements are indicated herein; and, except where project conditions require extra precautions or provisions to assure performance of the waterproofing system.

B. Authorized Installers: Caulking, sealants, and moisture protection shall be complete systems, and installed only by installers authorized and approved by the respective material manufacturers.

3.02 SEALANT FILLED JOINTS

A. Manufacturer's Representative: The Contractor shall furnish the on-site services of the sealant manufacturer's representative (before starting sealant work) for inspection of the joints to be sealed and for instructing the installer in the proper use of the materials.

B. Surface Preparation: Joints and spaces to be sealed shall be clean, dry, and free of dust, loose mortar, and other foreign materials. Ferrous metal surfaces shall be cleaned of all rust, mill scale, and other coatings by wire brush, grinding, or sandblasting. Oil and grease shall be removed by cleaning in accordance with sealant manufacturer's printed recommendations. Protective coatings shall be removed from all aluminum surfaces against which caulking or sealing compound is to be placed. Bituminous or resinous materials shall be removed from surfaces to receive caulking or sealants.

C. Sealant Depth: Sealant depth in joints shall be 1/2 the width of joint, but not less than 1/8 inch deep and ¼ inch wide nor more than ½ inch deep and 1 inch wide. All joints shall have a rigid filler material installed to proper depth prior to application of sealant.

D. Joints in Porous Materials: Where required by the manufacturer, sides of joints of porous materials shall be primed immediately prior to caulking or sealing.

E. Applications: A full bead of sealant shall be applied into the joint under sufficient pressure, with the nozzle drawn across sealant, to completely fill the void space and to ensure complete wetting of contact area to obtain uniform adhesion. During application the tip of the nozzle shall be kept at the bottom of the joint thereby forcing the sealant to fill from the bottom to the top. Sealants shall be tooled immediately after exposure with caulking tool or soft bristled brush moistened with solvent. The finished sealant filled joint shall be slightly concave unless otherwise indicated.

F. Cleaning: After application of sealant and caulking materials, adjacent materials which have been soiled shall be cleaned and left in a neat, clean, undamaged or unstained condition. On porous surfaces, excess sealant shall be removed per sealant or caulking manufacturer's printed instructions.

END OF SECTION 07900

SECTION 11300 - PUMPS, GENERAL

PART 1 - GENERAL

1.01 DESCRIPTION

A. The Contractor shall furnish and install all tools, equipment, materials, and supplies and shall perform all labor necessary for the installation, testing, and placing into operation of all pumps and pumping appurtenances, complete and operable, in accordance with the requirements of the Contact Documents.

B. The provisions of this Section shall apply to all pumps and pumping equipment specified, except where otherwise specified in the Contract Documents.

C. The Contractor shall assign to a single manufacturer full responsibility for the furnishing and functional operation of the complete pump system including the pumps, drives, drive motors, speed control equipment (where variable speed drives are required) and accessories. The designated single manufacturer, however, need not manufacture more than one part of the unit (pump, or motor and drive), but shall coordinate the design, assembly, testing, and erection of the unit(s) as specified herein.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Divisions 2 and 15 as applicable, Piping.

B. Section 01660 – Mechanical Equipment – Installation and Start-Up

C. Section 05500 - Miscellaneous Metals

D. Section 09800 - Protective Coating

E. Section 11000 - Equipment General Provisions

F. Section 11034 - Pressure Gauges

G. Section 16000 - General Electrical Requirements

H. Section 16481 - Motor Control Centers (MCC)

I. Section 15380 - Motors

J. Section 16310 - Variable Frequency Drive Units

J. Division 17 - Instrumentation

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Comply with the applicable reference specifications as specified in the General Requirements.

B. Commercial Standards:

ANSI B 16.1	Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800
ANSI B 16.5	Pipe Flanges and Flanged Fittings, Steel

	Nickel Alloy and Other Special Alloys
ANSI/ASME B 31.1	Power Piping
ANSI/ASME B 73.1M	Specifications for Horizontal End Suction Centrifugal Pumps for Chemical Process
ANSI/ASME B 73.2M	Specifications for Vertical In-Line Centrifugal Pumps for Chemical Process
ANSI/AWWA E 101	Deep Well Vertical Turbine Pumps - Line Shaft and Submersible Types
ANSI/IEEE 112	Test Procedure for Polyphase Induction Motors and Generators
ANSI/IEEE 115	Test Procedure for Synchronous Machines
ASTM A 48	Specification for Gray Iron Castings
ASTM A 470	Specification for Vacuum-Treated Carbon and Alloy Forgings for Turbine Rotors and Shafts

ASTM A 536	Specification for Ductile Iron Castings
ASTM E 448	Recommended Practice for Scleroscope Hardness Testing of Metallic Materials
ASTM B 62	Specification for Composition Bronze or Ounce Metal Castings
Latest Edition	Hydraulic Institute Standards for Centrifugal, Rotary, and Reciprocating Pumps

1.04 CONTRACTOR SUBMITTALS

A. Submittals shall be made in accordance with the General Requirements.

B. The following submittals and specific information shall be provided:

1. Pump name, identification number and specification number.

2. Performance curve and pump data.

3. The Contractor shall require the manufacturer to indicate points on the H/Q curves, and the limits recommended for stable operation between which the pumps may be operated without surge, cavitation and vibration. The stable operating range shall be as wide as possible based on the pumps actual hydraulic and mechanical tests.

4. Pump detailed description and specification.

5. Electrical data including control and wiring diagrams.

6. Assembly and installation drawings including shaft size, seal, coupling, anchor bolt plan, part nomenclature, material list, outline dimensions and shipping weights. Manufacturer shall also be required to supply calculations, signed by a registered California Professional Engineer, to establish the number, type size, length, embedment, etc. of anchor bolts needed to meet the Seismic requirements of the individual project location.

7. Pump drive and motor in accordance with Division 16 – Electrical and the Electrical Plans.

8. Bearing life calculations.

C. Certification: The Contractor shall obtain written certification from the pump manufacturer, addressed to the Owner, stating that the equipment will efficiently and thoroughly perform the required functions in accordance with these Specifications and as shown, and that the pump manufacturer accepts joint responsibility with the Contractor for coordination of all equipment, including motors, variable frequency drives, controls, and services required for proper installation and operation of the completely assembled and installed pumps. The Contractor shall submit all such certificates to the Engineer.

D. Technical Manuals: Prior to startup the Contractor shall furnish the Owner complete operations and maintenance manuals.

D. Tools: Special tools necessary for maintenance and repair of the pumps and one pressure

grease gun for each type of grease required for pumps and motors shall be furnished to the Owner as a part of the work hereunder; such tools shall be suitably stored in metal tool boxes, and identified with the equipment number by means of stainless steel or solid plastic name tags attached to the box.

E. Spare Parts: The Contractor shall obtain and submit from the manufacturer a list of recommended spare parts for each piece of equipment. After approval, Contractor shall furnish such spare parts suitably packaged, identified with the equipment number, and labeled. Contractor shall also furnish the name, address, and telephone number of the nearest distributor for each piece of equipment. All spare parts are intended for use by the Owner, only, after expiration of the guaranty period. Any spare parts which the Engineer permits the Contractor to use for startup activities shall be replaced by the Contractor prior to the Owner's acceptance of beneficial use of the equipment.

1. During the term of this Contract the Contractor shall notify the Engineer in writing about any manufacturer's modification of the approved spare parts, such as part number, interchangeability, model change or others. If the Engineer determines that the modified parts are no longer applicable to the supplied equipment, the Contractor at its expense shall provide applicable spare parts.

G. Field Procedures: Instructions for field procedures for erection, adjustments, inspection, and testing shall be provided prior to installation of the pumps.

1.05 QUALITY ASSURANCE

A. Performance Curves: All centrifugal pumps shall have a continuously rising curve. In no case shall the required horsepower at any point on the performance curve exceed the rated horsepower of the motor or engine.

B. Equipment Testing: The Contractor shall be responsible for the coordination of the following tests of each pump, drive, and motor:

1. General: Tests shall be performed in accordance with the Test Code for Centrifugal Pumps of the Standards of the Hydraulic Institute, Inc. Tests shall be performed on the actual assembled unit from shut-off head condition to 125 percent of the required maximum design capacity. Prototype model tests will not be acceptable. Pumps and motors shall be factory-tested, as defined herein.

2. Factory Tests of Pumps: All pumps and motors of sizes 10 to 125 hp (inclusive) shall be factory-tested in accordance with the above specifications. Six (6) sets of Certified test data shall be submitted to the ENGINEER. This data shall include, but not be limited to the following:

a. Hydrostatic test with data recorded.

b. Hydraulic test with a minimum of 5 readings between shut-off head and 125 percent of the maximum design capacity, recorded on data sheets as defined by the Hydraulic Institute, signed, dated, and certified.

c. Certified pump curves showing head/flow, bhp, efficiency, curves.

d. Certification that the pump hp demand will not exceed the rated motor hp beyond the 1.0 service rating at any point on the curve.

3. Factory Tests of Motors: All motors of sizes 10 hp and larger, shall be assembled, tested, and certified at the factory and the working clearances checked to insure that

all parts are properly fitted. The tests shall be in accordance with ANSI/IEEE 112 and ANSI/IEEE 115 standards, including heat run and efficiency tests. All computations shall be recorded and 7 certified and dated copies of the test results shall be furnished to the Engineer.

4. Factory Witnessed Tests: All pumps, variable speed drives, and motors, 150 hp and larger, shall be factory-tested as complete, assembled units, as specified above, and witnessed by the Engineer and the Manufacturer's Inspector. The manufacturer shall give the Engineer a minimum of 2 weeks notification prior to the test. All costs for Manufacturer's Inspector and Engineer shall be borne by the Contractor and included in the bid price. Such costs shall include travel and subsistence for 2 people but shall exclude any salaries. Test results in triplicate shall be submitted to the Engineer and no equipment shall be shipped until the test data have been approved by the Engineer and the Manufacturer's Inspector.

5. Acceptance: In the event of failure of any pump to meet any of the above requirements or efficiencies, the Contractor shall make all necessary modifications, repairs, or replacements to conform to the requirements of the Contract Documents and the pump shall be re-tested at no additional compensation, until found satisfactory.

C. Field Tests: All pumping units shall be field tested after installation, in accordance with the Contract Documents, to demonstrate satisfactory operation, without causing excessive noise, vibration, cavitation, and overheating of the bearings. The field testing shall be performed in the presence of an experienced field representative of the manufacturer of each major item of equipment, who shall supervise the following tasks and shall certify in writing that the equipment and controls have been properly installed, aligned, lubricated, adjusted, and readied for operation:

1. Start-up, check, and operate the equipment over the entire speed range. Any vibration shall be within the amplitude limits recommended in the Hydraulic Institute Standards and it shall be recorded at a minimum of 4 pumping conditions defined by the Engineer.

2. Pump performance shall be documented by obtaining concurrent readings, showing motor voltage, amperage, pump suction head, and pump discharge head, for at least 4 pumping conditions at each pump rpm. Each power lead to the motor shall be checked for proper current balance.

3. Bearing temperatures shall be determined by a contact-type thermometer. A running time of at least 20 minutes shall be maintained for this test, unless liquid volume available is insufficient for a complete test.

4. Electrical and instrumentation testing shall conform to applicable sections of these Specifications.

5. The field testing shall be witnessed by the Engineer and the Manufacturer's Representative. In the event any of the pumping equipment fails to meet the above test requirements, it shall be modified and retested in accordance with the requirements of these Specifications. The Contractor shall then certify in writing that the equipment has been satisfactorily tested, and that all final adjustments thereto have been made. Certification shall include date of final acceptance test, as well as a listing of all persons present during tests, and resulting test data. The costs of all work performed in this Paragraph by factory-trained representatives shall be borne by the Contractor. The Owner will pay for costs of power and water. When available, the Owner's operating personnel will provide assistance in the

field testing.

1.06 MANUFACTURER'S SERVICE REPRESENTATIVE

A. Erection and Startup Assistance: Service and instruction assistance by the manufacturer's engineering representative for each pump 10 hp and larger shall be provided by the Manufacturer during the following periods:

1. During erection.

2. During startup.

B. Instruction of Owner's Personnel: The Contractor shall provide for the services of a factory service representative to instruct the Owner's personnel in the operation and maintenance of the equipment. This service shall consist of a 2 day visit to the plant for each type of similar pumps.

1.07 GUARANTEES, WARRANTIES

A. After completion, the Contractor shall furnish to the Owner the manufacturer's written guarantees, that the pumping equipment will operate with the published efficiencies, heads, and flow ranges and meet these Specifications. The Contractor shall also furnish the manufacturer's warranties as published in its literature and as specified.

1.08 DELIVERY, STORAGE AND HANDLING

A. The manufacturer/supplier shall be responsible for the delivery of pump(s) to the Project Site. The equipment shall be delivered to the Project Site, Freight on Board, within 6 weeks of receiving an approved submittal.

B. The Contractor shall be responsible for unloading pump(s).

C. The delivery, storage, and handling of all plates, supports, members, and miscellaneous parts shall be packaged for shipment in such manner to prevent damage and abrasion of scratching of the finish coating.

D. The Contractor is responsible of the safe storage and protection of material and equipment associated with construction of pump(s).

PART 2 - PRODUCTS

2.01 GENERAL

A. The Contractor shall furnish and install only such pumping equipment as the designated single manufacturer certifies is suitable for use with its equipment and the service conditions.

B. All manufactured items provided under this Section shall be new, of current manufacture, and shall be the products of reputable manufacturers specializing in the manufacture of such products; such manufacturers shall have had previous experience in such manufacture and shall furnish the names of not less than 5 successful installations of its equipment of comparable nature to that offered under this contract.

C. All combinations of manufactured equipment which are provided under these Specifications shall be entirely compatible, and the Contractor and the designated single manufacturer shall be responsible for the compatible and successful operation of the various components of the

units conforming to specified requirements. Each unit of pumping equipment shall incorporate all basic mechanisms, coupling, electric motor or engine drive and unit mounting. All necessary mountings and appurtenances shall be included.

D. Where 2 or more units of the same type and/or size of pumping equipment are required, such units shall all be produced by the same manufacturer.

2.02 MATERIALS

A. All materials furnished as part of the pumping equipment shall be suitable for its intended use and service. Materials not specifically called for shall be high-grade, standard commercial quality, free from all defects and imperfection that might affect the serviceability of the product for the purpose for which it is intended, and shall conform to the following requirements:

1. Cast iron pump casings and bowls shall be of close-grained gray cast iron, conforming to ASTM A 48, or equal.

2. Bronze pump impellers shall conform to ASTM B 62.

3. Stainless steel pump shafts shall be of Type 400, Series. Miscellaneous stainless steel parts shall be of Type 316 stainless steel.

4. All anchor bolts, nuts and washers shall be Type 316 stainless steel, unless otherwise specified in individual pumping equipment specifications. Buried or submerged bolts, nuts and washers shall be of Type 316 stainless steel, unless otherwise specified by the Engineer.

2.03 PUMP APPURTENANCES

A. Nameplates: Each pump shall be equipped with a stainless steel nameplate indicating rated head and flow, impeller size, pump speed, and manufacturer's name and model number.

B. Solenoid Valves: The pump manufacturer shall furnish and install solenoid valves on the water or oil lubrication lines and on all cooling water lines. Solenoid valve electrical rating shall be compatible with the motor control voltage and shall be furnished complete with all necessary conduit and wiring installation from control panel to solenoid.

C. Pressure Gauges: All pumps (except sample pumps, sump pumps, and hot water circulating pumps) shall be equipped with pressure gauges installed at pump suction and discharge lines. Pressure gauges shall be located in a representative location, where not subject to shock or vibrations, in order to achieve true and accurate readings. Pressure gauges shall be furnished in accordance with the manufacturer’s recommendations.

D. Pump suctions shall be equipped with compound gauges. Where subject to shock or vibrations, the pressure gauges shall be provided with snubber and wall-mounted or attached to galvanized channel floor stands and connected by means of flexible connectors.

E. Variable Frequency Drives: Variable frequency drives, drive motors, speed control equipment, and accessories shall be furnished in accordance with applicable Division 11, 16 and 17 sections.

2.04 PUMP REQUIREMENTS

A. Flanges: Suction and discharge flanges shall conform to ANSI standard B 16.1 or B 16.5 dimensions.

B. Lubrication: Vertical pump shafts shall be product water-lubricated, unless otherwise specified. Deep-well pumps and pumps with dry barrels shall have water- or oil-lubricated bearings and seals.

C. Handholes: Handholes on pump casings shall be shaped to follow the contours of the casing to avoid any obstructions in the water passage.

D. Vortex Suppressors: Vertical pumps with insufficient submergence shall be furnished with vortex suppressors.

E. Drains: All gland seals, air valves, and cooling water drains, and drains from variable frequency drive equipment shall be piped to the nearest floor sink, or drain, with galvanized steel pipe or copper tube, properly supported with brackets at the expense of the Contractor.

F. Grease Lubrication: For all vertical propeller, mixed-flow, and turbine pumps, other than deep well pumps, of bowl sizes 10 inch and larger, the Contractor shall provide a stainless steel tube attached to the column for grease lubrication of bottom bearing.

G. Stuffing Boxes: Where stuffing boxes are specified for the pump seal, they shall be of the best quality, using the manufacturer's suggested materials best suited for the specific application. For sewage, sludge, drainage, and liquids containing sediments, the seals shall be fresh-water flushed, using lantern rings. If fresh water is not available, the seal shall be flushed with product water cleaned by means of a solids separator as specified in the individual pump specifications. Unless otherwise specified, the packing material shall be interlaced Teflon braiding, containing 50 percent ultrafine graphite impregnation to satisfy the following specification:

Shaft speeds	-	up to 2500 rpm
Temperature	-	up to 500 degrees F
pH range	-	0-14

H. Mechanical Seals: Unless otherwise specified mechanical seal designs shall be selected for highest reliability and for rugged service. Mechanical seals shall be provided and they shall be water-flushed, unless otherwise specified. Water flushing shall be as described above. The pump manufacturer shall furnish the appropriate and best quality mechanical seals available.

I. For all seal arrangements, a buffer fluid must be circulated a minimum 20 PSI above suction pressure, or as required by manufacturer, in order to maintain reliable seal performance.

J. Preferred seals for all services other than chemicals and corrosives should be equipped with non-clogging, single coil springs and non-sliding, internal, secondary elastomers. Metal parts are to be of 300 series, corrosion-resistant materials.

PART 3 - EXECUTION

3.01 INSTALLATION

A. General: Pumping equipment shall be installed in accordance with approved procedures submitted with the shop drawings and as shown, unless otherwise approved by the Engineer.

B. Alignment: Equipment shall be field tested to verify proper alignment, operation as specified, and freedom from binding, scraping, vibration, shaft runout, or other defects. Pump drive shafts shall be measured just prior to assembly to ensure correct alignment. Equipment shall be secured in position and fixed neatly in appearance.

C. Lubricants: The installation work shall include furnishing the necessary oil and grease for initial operation.

3.02 PROTECTIVE COATING

A. All exposed materials, except corrosion-resistant metals which have not been shop painted, shall be field coated as specified in Section 09800 - Protective Coatings. Shop painted items which suffered damage to the shop coating shall be touched up as specified in Section 09800 - Protective Coatings.

END OF SECTION 11300

SECTION 11440- PUMP SKID SYSTEM

Part I – GENERAL

1.01 DESCRIPTION

A. WORK INCLUDED

A. Variable Speed Packaged Pumping System

SYSTEM DESIGN PARAMETERS

MPC E2CME5-4 System Model Number	67 GPM System Design Flow Rate	145 PSI System Design Pressure	2 INCH System Piping Size
FLOODED Minimum Suction Pressure	415 VAC System Electrical Voltage		3 PHASE 60 HZ System Electrical Phase and Frequency
CME5-4 Pump Model Number	24.8 GPM Pump Capacity (GPM)		145 FEET Pump Total Head (Feet)
2 HP Pump Horsepower	3480 RPM Pump RPM	9.1 AMPS System Full Load Amperage	

1.02 REFERENCE STANDARDS

The work in this section is subject to the requirements of applicable portions of the following standards:

A. Hydraulic Institute
B. ANSI – American National Standards Institute
C. ASTM – American Society for Testing and Materials
D. IEEE – Institute of Electrical and Electronics Engineers
E. NEMA – National Electrical Manufacturers Association
F. NEC – National Electrical Code
G. ISO – International Standards Organization
H. UL – Underwriters Laboratories, Inc.

1.03 QUALITY ASSURANCE

A. Continuous Operation Equipment. The floating spray equipment shall operate continuously, all day and all night, using three-phase 415VAC as the power source.

B. No Visual Defects. The potable water pumping system equipment shall have no visual defects, and shall have high quality welds, assembly, and corrosion resistant finish.

C. Qualified Manufacturer/Supplier. The manufacturer of the equipment shall have extensive experience in the production and installation of such equipment. Manufacturer shall submit evidence of at least five (5) years experience and five (5) previous installations with site contact information.

D. Factory Startup Services. Delivery, installation, and startup services shall be included in the bid. For factory delivery and installation, services shall be performed by full-time factory employees experienced in the operation of this equipment and who have completed OSHA safety trainings applicable to this type of installation.

E. Within 30 days following installation, the manufacturer shall provide an installation report detailing as described in Section 1.04 - Submittals.

F. Warranty. The potable water pumping system equipment shall be warranted to be free of defects in materials and workmanship for a period of 2 years. See Performance Warranty Conditions in Part 3 following.

1.04 SUBMITTALS

A. Submittals shall be made in accordance with Section 1300 – Submittals and the General Requirements herein.

B. The awarded Bidder shall provide [3] copies of the following documents.

1. A qualification statement demonstrating compliance with Section 1.03.

2. Shop drawings for the installed equipment in accordance with Section 1300 – Submittals.

3. Manufacturer's literature, illustrations and specification sheets defining materials of construction, dimensions, and weights.

C. Final submittals shall include:

1. A complete installation, operation, and maintenance manual in conformance with Section 01730.

1.05 FIELD SERVICES

A. Startup and Training. Startup and training to be performed by full-time factory employees trained in the operation of the potable water pumping system in accordance with Sections 1660 and of the Specifications.

B. Training. The contractor shall provide at least eight (8) hours of training.

C. Safety Equipment. Installation personnel shall be equipped with job-specific safety equipment to complete the installation of all potable water pumping system equipment following all OSHA safety regulations. Safety equipment shall include confined space, fall protection, rescue, decontamination, and communication tools such as (air monitor, ventilation fan, tripod, winches, FBH's, retractable, ropes, lanyards, descenders, radios, hard hats, step pools, disinfectant sprayer, etc.)

Part 2 – PRODUCTS

2.01 VARIABLE SPEED PACKAGED PUMPING SYSTEM

A. Furnish and install a pre-fabricated and tested variable speed packaged pumping system to maintain constant water delivery pressure.

B. The packaged pump system shall be a standard product of a single pump manufacturer. The entire pump system including pumps and pump logic controller, shall be designed and built by the same manufacturer.

C. The complete packaged water booster pump system shall be certified and listed by UL (Category QCZJ – Packaged Pumping Systems) for conformance to U.S. and Canadian Standards.

2.02 PUMPS

A. All pumps shall be ANSI/NSF 61 approved for drinking water.

B. The pumps shall be of the in-line vertical multi-stage design.

C. The head-capacity curve shall have a steady rise in head from maximum to minimum flow within the preferred operating region. The shut-off head shall be a minimum of 20% higher than the head at the best efficiency point.

D. Large In-line Vertical Multi-Stage Pumps (Nominal flows from 130 to 500 gallons per minute) shall have the following features:

1. The pump impellers shall be secured directly to the smooth pump shaft by means of a split cone and nut design.

2. The suction/discharge base shall have ANSI Class 125 or Class 250 flange connections in a slip ring (rotating flange) design as indicated in the drawings or pump schedule.

3. Pump Construction.

a. Suction/discharge base, pump head	Ductile Iron (ASTM 65-45-12)
b. Shaft couplings, flange rings:	Ductile Iron (ASTM 65-45-12)
b. Shaft	431 Stainless Steel
c. Motor Stool	Cast Iron (ASTM Class 30)
d. Impellers, diffuser chambers, outer sleeve:	304 Stainless Steel
e. Impeller wear rings:	304 Stainless Steel
f. Intermediate Bearing Journals:	Tungsten Carbide
g. Intermediate Chamber Bearings:	Leadless Tin Bronze
h. Chamber Bushings:	Graphite Filled PTFE
I. O-rings:	EPDM

4. The shaft seal shall be a single balanced metal bellows cartridge with the following construction:

a. Bellows:	904L Stainless Steel
b. Shaft Sleeve, Gland Plate, Drive Collar:	316 Stainless Steel
c. Stationary Ring:	Carbon
d. Rotating Ring:	Tungsten Carbide
e. O-rings:	EPDM

5. Shaft seal replacement shall be possible without removal of any pump components other than the coupling guard, motor couplings, motor and seal cover. The entire cartridge shaft seal shall be removable as a one piece component. Pumps with motors equal to or larger than 15 hp (fifteen horsepower) shall have adequate space within the motor stool so that shaft seal replacement is possible without motor removal.

2.03 VARIABLE FREQUENCY DRIVES (Panel Mount)

A. The VFD shall convert incoming fixed frequency single-phase or three-phase AC power into a variable frequency and voltage for controlling the speed of three-phase AC induction motors. The VFD shall be a six-pulse input design, and the input voltage rectifier shall employ a full wave diode bridge; VFD's utilizing controlled SCR rectifiers shall not be acceptable. The output waveform shall closely approximate a sine wave. The VFD shall be of a PWM output design utilizing current IGBT inverter technology and voltage vector control of the output PWM waveform.

B. The VFD shall include a full-wave diode bridge rectifier and maintain a displacement power factor of near unity regardless of speed and load.

C. The VFD shall produce an output waveform capable of handling maximum motor cable distances of up to 1,000 ft. (unshielded) without tripping or derating.

D. The VFD shall utilize an output voltage-vector switching algorithm, or equivalent, in both variable and constant torque modes. VFD's that utilize Sine-Coded PWM or Look-up tables shall not be acceptable.

E. VFD shall automatically boost power factor at lower speeds.

F. The VFD shall be able to provide its full rated output current continuously at 110% of rated current for 60 seconds.

G. An empty pipe fill mode shall be available to fill an empty pipe in a short period of time, and then revert to the PID controller for stable operation.

H. Switching of the input power to the VFD shall be possible without interlocks or damage to the VFD at a minimum interval of 2 minutes.

I. Switching of power on the output side between the VFD and the motor shall be possible with no limitation or damage to the VFD and shall require no additional interlocks.

J. The VFD shall have temperature controlled cooling fans for quiet operation, minimized internal losses, and greatly increased fan life.

K. VFD shall provide full torque to the motor given input voltage fluctuations of up to +10% to -15% of the rated input voltage.

L. The VFD shall provide internal DC link reactors to minimize power line harmonics and to provide near unity power factor. VFD's without a DC link reactor shall provide a 5% impedance line side reactor.

M. VFD to be provided with the following protective features:

1. VFD shall have input surge protection utilizing MOV's, spark gaps, and Zener diodes to withstand surges of 2.3 times line voltage for 1.3 msec.

2. VFD shall include circuitry to detect phase imbalance and phase loss on the input side of the VFD.

3. VFD shall include current sensors on all three-output phases to detect and report phase loss to the motor. The VFD will identify which of the output phases is low or lost.

4. VFD shall auto-derate the output voltage and frequency to the motor in the presence of sustained ambient temperatures higher than the normal operating range, so as not to trip on an inverter temperature fault. The use of this feature shall be user-selectable and a warning will be exported during the event. Function shall reduce switching frequency before reducing motor speed.

5. VFD shall auto-derate the output frequency by limiting the output current before allowing the VFD to trip on overload. Speed can be reduced, but not stopped.

6. The VFD shall have the option of an integral RFI filter. VFD enclosures shall be made of metal to minimize RFI and provide immunity.

N. VFD to be provided with the following interface features:

1. VFD shall provide an alphanumeric backlit display keypad, which may be remotely mounted using standard 9-pin cable. VFD may be operated with keypad disconnected or removed entirely. Keypad may be disconnected during normal operation without the need to stop the motor or disconnect power to the VFD.

2. VFD shall display all faults in plain text; VFD's, which can display only fault codes, are not acceptable.
3. All VFD's shall be of the same series, and shall utilize a common control card and LCP (keypad/display unit) throughout the rating range. The control cards and keypads shall be interchangeable through the entire range of drives used on the project.
4. VFD keypad shall be capable of storing drive parameter values in non-volatile RAM uploaded to it from the VFD, and shall be capable of downloading stored values to the VFD to facilitate programming of multiple drives in similar applications, or as a means of backing up the programmed parameters.
5. A red FAULT light, a yellow WARNING light and a green POWER-ON light shall be provided. These indications shall be visible both on the keypad and on the VFD when the keypad is removed.
6. A start guide menu with factory preset typical parameters shall be provided on the VFD to facilitate commissioning.
7. VFD shall provide full galvanic isolation with suitable potential separation from the power sources (control, signal, and power circuitry within the drive) to ensure compliance with PELV requirements and to protect PLC's and other connected equipment from power surges and spikes.
8. All inputs and outputs shall be optically isolated. Isolation boards between the VFD and external control devices shall not be required.
9. There shall be three programmable digital inputs for interfacing with the systems external control and safety interlock circuitry. An additional digital input is preprogrammed for start/stop.
10. The VFD shall have two analog signal inputs. One dedicated for sensor input and one for external set point input.
11. One programmable analog output shall be provided for indication of a drive status.
12. The VFD shall provide two user programmable relays with selectable functions. Two form 'C' 230VAC/2A rated dry contact relay outputs shall be provided.
13. The VFD shall store in memory the last 5 faults with time stamp and recorded data.
14. The VFD shall be equipped with a standard RS-485 serial communications port for communication to the multi-pump controller. The bus communication protocol for the VFD shall be the same as the controller protocol.

O. VFD service conditions:

1. Ambient temperature operating range, -10 to 45ºC (14 to 113°F).
2. 0 to 95% relative humidity, non-condensing.
3. Elevation to 1000 meters (3,300 feet) without derating.
4. VFD's shall be rated for line voltage of 525 to 690VAC, 380 to 480VAC, or 200 to 240VAC; with +10% to -15% variations. Line frequency variation of ± 2% shall be acceptable.
5. No side clearance shall be required for cooling of the units.

2.04 PUMP SYSTEM CONTROLLER

A. The pump system controller shall be a standard product developed and supported by the pump manufacturer.

B. The controller shall be microprocessor based capable of having software changes and updates via personal computer (notebook). The controller user interface shall have a VGA display with a minimum screen size of 3-1/2" x 4-5/8" for easy viewing of system status parameters and for field programming. The display shall have a back light with contrast adjustment. Password protection of system settings shall be standard.

C. The controller shall provide internal galvanic isolation to all digital and analog inputs as well as all fieldbus connections.

D. The controller shall display the following as status readings from a single display on the controller (this display shall be the default):

- Current value of the control parameter, (typically discharge pressure)
- Most recent existing alarm (if any)
- System status with current operating mode
- Status of each pump with current operating mode and rotational speed as a percentage (%)

E. The controller shall have as a minimum the following hardware inputs and outputs:

- Three analog inputs (4-20mA or 0-10VDC)
- Three digital inputs
- Two digital outputs
- Ethernet connection
- Field Service connection to PC for advanced programming and data logging

F. Pump system programming (field adjustable) shall include as a minimum the following:

- Water shortage protection (analog or digital)
- Transducer Settings (Suction and Discharge Analog supply/range)
- PI Controller (Proportional gain and Integral time) settings
- High system pressure indication and shut-down
- Low system pressure indication and shut-down
- Low suction pressure/level shutdown (via digital contact)
- Low suction pressure/level warning (via analog signal)
- Low suction pressure/level shutdown (via analog signal)
- Flow meter settings (if used, analog signal)

G. The system controller shall be able to accept up to seven programmable set-points via a digital input, (additional input/output module may be required).

H. The controller shall have advanced water shortage protection. When analog sensors (level or pressure) are used for water shortage protection, there shall be two indication levels. One level is for warning indication only (indication that the water level/pressure is getting lower than expected levels) and the other level is for complete system shut-down (water or level is so low that pump damage can occur). System restart after shut-down shall be manual or automatic (user selectable).

I. The system pressure set-point shall be capable of being automatically adjusted by using an external set-point influence. The set-point influence function enables the user to adjust the control parameter (typically pressure) by measuring an additional parameter. (Example: Lower the system pressure set-point based on a flow measurement to compensate for lower friction losses at lower flow rates).

J. The controller shall be capable of receiving a remote analog set-point (4-20mA or 0-10 VDC) as well as a remote system on/off (digital) signal.

K. The pump system controller shall store up to 24 warning and alarms in memory. The time, date and duration of each alarm shall be recorded. A potential-free relay shall be provided for alarm notification to the building management system. The controller shall display the following alarm conditions:

High System Pressure	Low system pressure
Low suction pressure (warning and/or alarm)	Individual pump failure
VFD trip/failure	Loss of sensor signal (4-20 mA)
Loss of remote set-point signal (4-20mA)	System power loss

L. The pump system controller shall be mounted in a UL Type 3R rated enclosure. A self-certified NEMA enclosure rating shall not be considered equal. The entire control panel shall be UL 508 listed as an assembly. The control panel shall include a main disconnect, circuit breakers for each pump and the control circuit and control relays for alarm functions.

M. The controller shall be capable of receiving a redundant sensor input to function as a backup to the primary sensor (typically discharge pressure).

N. The controller shall have a pump "Test Run" feature such that pumps are switched on during periods of inactivity (system is switched to the "off" position but with electricity supply still connected). The inoperative pumps shall be switched on for a period of two to three (2-3) seconds every 24 hours, 48 hours or once per week (user selectable).

O. The controller shall be capable of displaying instantaneous power consumption (Watts or kilowatts) and cumulative energy consumption (kilowatt-hours).

P. The actual pump performance curves (5^{th} order polynomial) shall be loaded (software) into the pump system controller.

2.05 SEQUENCE OF OPERATION

A. The system controller shall operate equal capacity variable speed pumps to maintain a constant discharge pressure (system set-point). The system controller shall receive an analog signal [4-20mA] from the factory installed pressure transducer on the discharge manifold, indicating the actual system pressure. As flow demand increases the pump speed shall be increased to maintain the system set-point pressure. When the operating pump(s) reach 96% of full speed (adjustable), an additional pump will be started and will increase speed until the system set-point is achieved. When the system pressure is equal to the system set-point all pumps in operation shall reach equal operating speeds. As flow demand decreases the pump speed shall be reduced while system set-point pressure is maintained. When all pumps in operation are running at low speed the system controller shall switch off pumps when fewer pumps are able to maintain system demand.

B. The system controller shall be capable of switching pumps on and off to satisfy system demand without the use of flow switches, motor current monitors or temperature measuring devices.

C. All pumps in the system shall alternate automatically based on demand, time and fault. If flow demand is continuous (no flow shut-down does not occur), the system controller shall have the capability to alternate the pumps every 24 hours, every 48 hours or once per week. The interval and actual time of the pump change-over shall be field adjustable.

2.06 LOW FLOW STOP FUNCTION

The system controller shall be capable of stopping pumps during periods of low-flow or zero-flow without wasting water or adding unwanted heat to the liquid. Temperature based no flow shut-down methods that have the potential to waste water and add unwanted temperature rise to the pumping fluid are not acceptable.

If a low or no flow shut-down is required (periods of low or zero demand) a bladder type diaphragm tank shall be installed with a pre-charge pressure of 70% of system set-point. The tank shall be piped to the discharge manifold or system piping downstream of the pump system. When only one pump is in operation the system controller shall be capable of detecting low flow (less than 10% of pump nominal flow) without the use of additional flow sensing devices. When a low flow is detected, the system

controller shall increase pump speed until the discharge pressure reaches the stop pressure (system set-point plus 50% of programmed on/off band). The pump shall remain off until the discharge pressure reaches the start pressure (system set-point minus 50% of programmed on/off band). Upon low flow shut-down a pump shall be restarted in one of the following two ways:

A. Low Flow Restart: If the drop in pressure is slow when the start pressure is reached (indicating the flow is still low), the pump shall start and the speed shall again be increased until the stop pressure is reached and the pump shall again be switched off.

B. Normal Flow Restart: If the drop in pressure is fast (indicating the flow is greater than 10% of pump nominal flow) the pump shall start and the speed shall be increased until the system pressure reaches the system set-point.

2.07 SYSTEM CONSTRUCTION

A. The suction and discharge manifolds shall be constructed of 316 stainless steel. Manifold connection sizes shall be as follows:

3 inch and smaller:	Male NPT threaded
4 inch through 8 inch:	ANSI Class 150 rotating flanges
10 inch and larger:	ANSI Class 150 flanges

B. Pump Isolation valves shall be provided on the suction and discharge of each pump. Isolation valve sizes 2 inch and smaller shall be nickel plated brass full port ball valves. Isolation valve sizes 3 inch and larger shall be a full lug style butterfly valve. The valve disk shall be of stainless steel. The valve seat material shall be EPDM and the body shall be cast iron, coated internally and externally with fusion-bonded epoxy.

B. A spring-loaded non-slam type check valve shall be installed on the discharge of each pump. The valve shall be a wafer style type fitted between two flanges. The head loss through the check valve shall not exceed 5 psi at the pump design capacity. Check valves 1-1/2" and smaller shall have a POM composite body and poppet, a stainless steel spring with EPDM or NBR seats. Check valves 2" and larger shall have a body material of stainless steel or epoxy coated iron (fusion bonded) with an EPDM or NBR resilient seat. Spring material shall be stainless steel. Disk shall be of stainless steel or leadless bronze.

C. For systems that require a diaphragm tank, a connection of no smaller than ¾" shall be provided on the discharge manifold. The system shall be provided with a non-ASME code epoxy coated steel shell bladder tank with FDA approved butyl rubber diaphragm, 150 PSI rated, sized at 86 gallon size by manufacturer for proper operation of pump system.

D. A pressure transducer shall be factory installed on the discharge manifold (or field installed as specified on plans). Systems with positive inlet gauge pressure shall have a factory installed pressure transducer on the suction manifold for water shortage protection. Pressure transducers shall be made of 316 stainless steel. Transducer accuracy shall be +/- 1.0% full scale with hysteresis and repeatability of no greater than 0.1% full scale. The output signal shall be 4-20 mA with a supply voltage range of 9-32 VDC.

E. A bourdon tube pressure gauge, 2.5 inch diameter, shall be placed on the suction and discharge manifolds. The gauge shall be liquid filled and have copper alloy internal parts in a stainless steel case. Gauge accuracy shall be 2/1/2 %. The gauge shall be capable of a pressure of 30% above its maximum span without requiring recalibration.

F. Systems with a flooded suction inlet or suction lift configuration shall have a factory installed water shortage protection device on the suction manifold.

G. The base frame shall be constructed of corrosion resistant 304 stainless steel. Rubber vibration dampers shall be fitted between each pumps and baseframe to minimize vibration.

H. Depending on the system size and configuration, the control panel shall be mounted in one of the following ways:

On a 304 stainless steel fabricated control cabinet stand attached to the system skid.
On a 304 stainless steel fabricated skid, separate from the main system skid
On its own base (floor mounted with plinth)

2.08 TESTING

A. The entire pump station shall be factory performance tested as a complete unit prior to shipment. Job-site programming shall be entered into the controller prior to shipment (details of installation requirements shall be communicated to the pump system manufacturer). A verified performance test report shall be made available from the system manufacturer.

B. The system shall undergo a hydrostatic test of 350 psig for a minimum of 15 minutes prior to shipment.

2.09 WARRANTY

A. The warranty period shall be a non-prorated period of 24 months from date of installation, not to exceed 30 months from date of manufacture.

END OF SECTION 11440

SECTION 11540 - CHEMICAL METERING PUMP SKID

PART 1 - GENERAL

1.01 DESCRIPTION

A. The Contractor shall furnish and install preassembled chemical dosing pump skids, together with all piping, valves, controls, as illustrated on the Plans and in accordance with the requirements of the Contract Documents.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 01330 – Submittals / Shop Drawings

B. Section 11610 - Chemical Feeding Equipment, General.

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Comply with the applicable reference specifications as specified in the General Requirements.

1.04 CONTRACTOR SUBMITTALS

A. Submittals shall be made in accordance with Section 01330 – Submittals / Shop Drawings.

B. Shop Drawings: Complete fabrication, assembly, foundation, and installation drawings, together with detailed specifications and data covering materials used, power drive assemblies, parts, devices, pumps, supports, and other accessories forming the skid equipment as well as schematics, diagrams, and skid layouts, shall be submitted for review.

C. Certification: The Contractor shall obtain written certification from the manufacturer, addressed to the Owner, stating that the equipment will provide the capability to handle the design chemical efficiently and thoroughly perform the required functions in accordance with these Specifications and as indicated on the Plans, and that the manufacturer accepts joint responsibility with the Contractor for coordination of all equipment, including pumps, controls, and services required for proper installation and operation of the completely assembled and installed unit. The Contractor shall submit all such certificates to the Owner's Representative.

D. Technical: Prior to start-up the Contractor shall furnish to the Owner complete operations and maintenance manuals in accordance with Technical Manuals of the General Requirements.

1.05 QUALITY ASSURANCE (NOT USED)

PART 2 - PRODUCTS

2.01 GENERAL

A. The pumps shall be of corrosion-resistant construction and diaphragm and seals shall be a suitable material for the chemicals indicated at maximum temperature of 125 degrees F. Each pump shall be complete with pump base, motor driven diaphragm, check valves, back-pressure valve, internal relief valve, pulsation dampener, union, and any other items

as shown on the plans. A complete set of extra diaphragms and seals shall be furnished with each pump. Size and characteristics of the pumps shall be as specified herein.

2.02 CONSTRUCTION

A. General: The chemical metering pumps shall be of the positive displacement, diaphragm dosing type pumps with variable speed drive (stepper motor) with microprocessor control. All metering pumps shall be the product of a single manufacturer. Parts coming into contact with the liquid shall be selected to ensure optimum corrosion resistance to the liquid being pumped. The liquid being pumped is a 4 percent Sodium Hypochlorite.

B. Type and Range: Each metering pump shall be of the stepper motor driven mechanically actuated diaphragm type. Solenoid driven or hydraulically actuated diaphragm pumps are not acceptable. Peristaltic pumps are acceptable. The capacity range up to 4.5 GPH.

C. All pumping functions set, or in progress shall be displayed on the graphical display. Metering pump electronics shall be enclosed in a glass fiber reinforced plastic housing, mounted to the rear of the chemical metering pump. The housing shall be rated Nema 4X and shall be shock resistant.

D. The metered liquid shall enter the metering head at the bottom and exit at the top through gravity seating double ball check valves. These valves shall be free-seating type with valve seats and shall be guided to accurately control vertical and sideways motion. Check valves shall be threaded union type to eliminate clamping bars and other metal parts subject to corrosion. Plastic parts shall be molded and stress relieved for strength.

E. The pump mechanism shall be sealed from direct contact with the outside atmosphere and suitable for operation in ambient conditions to 113 degrees F (104 degrees F for PVC) and fluid temperatures to 95 degrees F for PVC, 140 degrees F for Polypropylene, and 176 degrees F for PVDF and 316SS.

F. Materials of construction for the pump include a (PVC) pump head and check valves, glass ball checks, (Viton) seals and a PTFE-coated EPDM diaphragm.

G. An integral multi-language, easy-logic menu control system with graphical display guidance shall be available as standard. A North American power cord shall be prewired.

H. Four multifunctional keys below the graphical display shall operate the menu structure. The respective function of each key shall be visualized at the bottom of the display. Time, date (including day of week, month, year) and language shall be fully programmable. Graphical display shall indicate units of capacity over a period of time. These units of capacity can be programmed as gallons, liters, or milliliters. Units of dosing time can be programmed as per day, hour or minute. Dosing pumps that do not display flow rate in units of flow (gallons, liters), that rely on external controllers or those without a menu control system with graphical interface are not acceptable.

I. The pump shall be capable of achieving its full flow range by stroke speed adjustment with up to 150 strokes per minute (depending on model). The metering pump shall offer the following operating modes: Manual, analog input, pulse input, or batch mode. The operating mode of the pump shall be clearly displayed as an easy to recognize icon as well as text representation on the main display.

J. Automatic capacity control from a 4-20 mA analog signal or pulse signal shall be available.

K. The control unit shall have the capability to log all disturbance messages with a date, time and error code.

L. To prevent unauthorized main menu access, a "release code" can be programmed. This password can be a series of 4 numbers, each selectable between 0 and 9.

M. Variable Frequency Drive controlled pumps shall be equipped with a variable speed controller and able to receive 4 - 20 mA signal as generated by a PLC.

2.04 CONFIGURATION

A. The design shall consist of two (2) 2 pump (duty and standby) chemical dosing skids for 12.5% sodium hypochlorite and 38% sodium metabisulfite. Each skid will be mounted to the P.C.C. concrete slab and aluminum panel supports. Each skid shall contain 2 junction boxes for power and control.

2.05 PUMP ACCESSORIES

A. Mounting and Connections: Unless otherwise shown, all metering pumps shall be mounted within the skid and they shall be provided with corrosion-resistant pulsation dampeners, sample valves, pressure gages with diaphragm seals, shut-off valves, check valves, relief valves, valves and graduated calibration tanks in pump suction. All pipe connections to feeders must be firmly supported from a floor-mounted, galvanized, structural steel frame, to avoid any stress on the feeder or on the piping system.

2.06 SPARE PARTS

A. All chemical feeders shall be furnished with a complete set of one year's manufacturer suggested spare parts, such as seals, packing, gaskets, belts, and any other parts subject to wear. Where applicable, one set of spare bearings shall be furnished with each piece of equipment.

2.07 MANUFACTURER

A. Manufacturer's Experience: The chemical feeding equipment shall be the product of a manufacturer who has designed and manufactured similar equipment and has a record of at least 5 years of successful operation of this type of process. The Contractor may be required to submit evidence to this effect together with a representative list of installations. The pump manufacturer shall maintain a permanent, local service department and a spare parts department.

B. Manufacturers:

1. Model: Encore 700 Simplex Metering Pump
UGSI Chemical Feed
1695 National Avenue
San Diego, CA 92113
Ph: 619-232-7867

2. Model: DMH Series
Grundfos Alldos
Barrett Engineered Pumps
1695 National Avenue

San Diego, CA 92113
Ph: 619-232-7867

3. Or equal.

C. Unit Responsibility: The Contractor shall assign to a single manufacturer full responsibility for the furnishing and functional operation of the chemical feeder system along with all related tanks, mixers, pumps, piping, valves and controls. The designated single manufacturer, however, need not manufacture more than one part of the system. The designated manufacturer shall coordinate the design, assembly, testing, and erection of the system as specified.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Pumping equipment shall be installed in accordance with approved procedures submitted with the shop drawings and as shown, unless otherwise approved.

B. General Installation requirements shall be as specified in Section 11000 – Equipment – General Provisions.

END OF SECTION 11540

SECTION 13320 - HIGH DENSITY CROSSLINKED POLYETHYLENE TANKS

PART 1 - GENERAL

1.01 DESCRIPTION

A. General: The Contractor shall furnish all labor, equipment, materials, tools, supplies, fittings, and appurtenances required for the fabrication, support, installation, anchorage, hook-up, lining, protective coating, and testing of double wall high density crosslinked polyethylene tank(s), and all appurtenant work, for a complete and workable installation as specified herein, in accordance with the requirements of the Contract Documents.

B. All plastic tanks shall be manufactured of material suitable for the chemicals they serve, and shall be certified for such use on the shop drawings. Tanks shall be designed and checked for all loads to be incurred during service, including, but not limited to, wind, temperature stress and earthquake loads by a registered (California) engineer with a minimum of five (5) years experience in high density crosslinked polyethylene tanks. All designs and calculations shall be signed by the registered engineer and submitted to the Owner for approval.

C. The manufacturer shall have been regularly engaged in the design and manufacture of High Density Polyethylene Tanks such as specified herein for at least five (5) years. The tank manufacturer's experience shall include at least five (5) tank installations, of equal or larger capacity than specified herein, that have been in operation for at least five (5) years. Manufacturer shall submit references for a minimum of five (5) installations where the equipment has been used to store the specified chemicals for at least five (5) years.

D. The tank shall be warranted for five (5) years to be free of defects in material and workmanship. The tank shall be warranted for five (5) years for the storage of the specified chemical.

E. UL Listed Tanks: Manufacturer shall have the capability of manufacturing UL Listed "Above Ground Chemical Storage Tanks" and UL Classified ANSI/NSF61 potable water storage tanks. The tanks as specified herein shall be UL Labeled.

F. NSF / ANSI STANDARD 61

Piping, fittings, and appurtenances in contact with potable water or water that will be treated to become potable shall be listed in NSF / ANSI Standard 61 as being suitable for contact with potable water.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. The Work of the following Sections applies to the Work of this Section. Other Sections of the Specifications, not referenced below, shall also apply to the extent required for proper performance of this Work.

B. Section 11000 - Equipment General Provisions.

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Comply with the reference specifications of the General Requirements.

B. Comply with the current provisions of the following codes and standards.

1. Commercial Standards:

ASTM D 638	Test Method for Tensile Properties of Plastics
ASTM D 695	Test Method for Compressive Properties of Rigid Plastics
ASTM D 746	Test Method for Brittleness Temperature of Plastics and Elastomers by Impact
ASTM D 883	Definitions of Terms Relating to Plastics
ASTM D 1998	Standard Specification for Polyethylene Upright Storage Tanks (Type I Tanks)
ASTM D 1505	Test Method for Density of Plastics by the Density-Gradient Technique
ASTM D 1525	Test Method for Vicat Softening Temperature of Plastics
ASTM D 1693	Test Method for Environmental Stress-Cracking of Ethylene Plastics
NSF / ANSI 61	Drinking Water System Components – Health Effects
UL Listed	Above Ground Chemical Storage Tanks

When two or more of the above regulations are applicable, the more stringent requirement shall be met.

1.04 CONTRACTOR SUBMITTALS

A. Shop Drawings: The Contractor shall furnish shop drawings of all items and accessories in accordance with the General Requirements.

B. Data Requirements: The drawings and data submitted shall include the following:

1. Dimensions including anchor bolt layouts.

2. Nozzle schedule including size, mark, thickness, and rating.

3. Details of structural supports and anchor systems.

4. Tank capacity (gallons).

5. Design specific gravity of 1.50

6. Wall thickness calculations.

7. Seismic calculations in accordance with the current Uniform Building Code.

8. Chemical resistant data.

9. Installation and repair manual.

10. Manufacturer's warranty statement.

C. NSF /ANSI Standard 61: Documentation illustrating manufacturer's certification of NSF / ANSI Standard 61 – Drinking Water System Components.

D. Factory Test: Data submitted shall include the following:

1. Visual Inspection

2. Gel Testing

3. Hydrostatic Testing

1.05 QUALITY ASSURANCE

A. Quality Assurance shall be in accordance with Section 11000 - Equipment General Provisions.

B. Tank shall be manufactured from material certified to NSF / ANSI Standard 61 for chemical storage.

PART 2 - PRODUCTS

2.01 HIGH DENSITY CROSSLINKED POLYETHYLENE TANKS

A. General: The Contractor shall furnish and install tanks of capacity and dimensions as illustrated on the Plans.

B. Standards: Construction of tanks shall be in accordance with ASTM standards listed herein.

C. Design: High Density Polyethylene tanks shall be rotationally molded of High-Density Crosslinked Polyethylene (XLPE), double wall, flat bottom and domed top.

The tank(s) is to be designed for above ground, vertical installation and storage of chemical (as noted in the Plans). The XLPE resin shall contain 1/2 to 1 percent ultraviolet stabilizer. Where black tanks are specified, the XLPE resin shall contain 1/2 to 1 percent carbon black as blended by the XLPE resin manufacturer. The tanks shall be able to operate at ambient temperatures of 40°F - 150°F in the outdoors without deformation or degradation. The XLPE resin properties shall meet or exceed the following:

PROPERTY	ASTM TEST	VALUE
Density (gm/cc)	D 1505	0.93-0.944
Tensile Strength Ultimate, 2"/min (psi)	D 638	2600
Elongation at Break, 2"/min (%)	D 638	400
ESCR, Condition A, F50, (hrs)	D 1693	> 1000
Vicat Softening Temperature (deg F)	D 746	230
Brittleness Temperature (deg F)	D 746	> 180
Flexural Modulus (psi)	D 790	100,000

D. Connections: Tank connections shall be installed by manufactured per size, location and type as specified in the tank connection schedule below and as illustrated on the Plans. Gasket material shall be XLPE. Refer to the tank drawing for tank connections size and location.

Inlet, Outlet, Drain And Overflow	PVC Flange Connection - Donker Bolt Fitting with hastelloy-C studs and internal polyethylene injection molded encapsulated heads and external PVC flange - location as illustrated on the Plans.
Vent	Self-aligning dome-top PVC fitting with fiberglass screen between 2 flanges - location as illustrated on the Plans.
Level Probe	1-1/4" PVC FNPT connection - located on the top.
Level Indication	An ultrasonic level indicator (transmitter) shall be provided. An ultrasonic level indicator shall be suitable for service in a non-hazardous and hazardous environment. The ultrasonic level transducer shall be provided with a 50 feet wiring and be controlled from the pertaining chemical's Control Panel. The ultrasonic level indicator shall provide a 4 – 20 mA signal output. The ultrasonic level transmitter shall meet the requirements of the technical specifications.
Maintenance Manhole	24" Integrally Molded with hinged cover - - located on the top.

E. Testing: The manufacturer shall furnish proof indicating that the following factory tests have been performed on the tanks, and specified test results have been achieved.

Gel Test - Gel test shall be performed in accordance with ASTM D1998 Section 11.4. Test results shall indicate that the innermost 1/8" of wall thickness shall be no less than 65 percent gel, the outermost 1/8" of wall thickness shall be no less than 80 percent gel, and the total wall thickness shall be no less than 75 percent gel.

Visual – Inspection for confirmation accurate fitting location, or defects of the tank.

Low Temperature Impact Test - Low temperature impact test shall be performed in accordance with ASTM D 1998, Section 11.3.

Hydrostatic Leak Test: Manufacturer shall have the capability of hydrostatically testing the tank and factory installed fittings with water.

The hydrostatic test shall incorporate the use of a standpipe to compensate for the difference in density of water and the chemical for which service of tank is specified. Test results shall indicate that no leakage has occurred over a 12 hour test duration.

2.02 BOLTS, ANCHOR BOLTS, WASHERS, SUPPORTS, AND HOLD DOWN LUGS

A. The Contractor shall provide all bolts, anchor bolts, nuts, washers, and supports as required for all the plastic tanks specified in this Section, and in accordance with the requirements of the manufacturers of the plastic tanks. All bolts, anchor bolts, washers, in connection with this Section shall be of Type 316 stainless steel. The lateral tank restraint system shall be designed for Seismic forces in accordance with the current edition of the Uniform Building Code. Restraint system components shall be Type 316 stainless steel.

2.03 MANUFACTURERS

A. Core-Rosion Products
3300 E. 19th Street
Signal Hill, CA 90755
1-562-986-5238
www.core-rosion.com

B. Polyprocessing
8055 S. Ash Street
French Camp, CA 95231
1-877-325-3142
www.polyprocessing.com

C. Assmann Corporation
300 North Taylor Road
Garrett, IN 46738
1-888-357-3181
www.assmann-usa.com

D. Or an approved equal.

PART 3 - EXECUTION

3.01 DELIVERY, STORAGE AND HANDLING

A. The tank shall be shipped upright or lying down on their sides with blocks and slings to keep them from moving.

B. All fittings shall be installed and, if necessary, removed for shipping and shipped separately unless otherwise noted by the Contractor.

C. Upon arrival at the destination, inspect the tank(s) and accessories for damage in transit. If damage has occurred, Manufacturer/Supplier is to be notified immediately.

3.02 INSTALLATION

A. All high density crosslinked polyethylene tanks shall be installed in accordance with manufacturer instructions. All pipes and equipment connecting to the tanks shall be firmly supported, to prevent stresses on the tank.

3.03 FIELD INSPECTION

A. The field inspection shall include the following:

1. A hydrotest of at least 24 hours shall be performed. The tank shall be filled with water to the overflow level and be observed for leaks. If leaks are observed, the tank shall be repaired or replaced at the Engineer's discretion at no cost to the Owner.

END OF SECTION 13320

SECTION 13480 - ALUMINUM ACCESS HATCH

PART 1 - GENERAL

1.01 DESCRIPTION

A. The Contractor shall furnish and install aluminum access hatch(s) and all appurtenant work, complete and operable, all in accordance with the requirements of the Contract Documents.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 03300 - Cast-in-Place Concrete.

1.03 REFERENCE, SPECIFICATIONS, CODES AND STANDARDS

A. ASTM A 36-93a: Standard Specification for Structural Steel.

1.04 CONTRACTOR SUBMITTALS

A. Product Data: Provide manufacturer's product data for all materials in this Specification.

B. Shop Drawings: Show profiles, accessories, location and dimensions.

C. Samples: Manufacturer to provide upon request; sized to represent material adequately.

D. Contract Closeout: Aluminum access door manufacturer shall provide the manufacturer's warranty prior to the contract closeout.

1.05 QUALITY ASSURANCE

Not used.

1.06 DELIVERY, STORAGE AND HANDLING

A. All materials shall be delivered in manufacturer's original packaging.

B. Store materials in a dry, protected, well-vented area. The Contractor shall thoroughly inspect product upon receipt and report damaged material immediately to delivering carrier and note such damage on the carrier's freight bill of lading.

C. Remove protective wrapping immediately after installation.

1.07 WARRANTY/GUARANTEE

A. Manufacturer's Standard Warranty: Materials shall be free of defects in material and workmanship for a period of twenty-five (25) years from the date of purchase. Should a part fail to function in normal use within this period, manufacturer shall furnish a new part at no charge.

PART 2 - PRODUCTS

2.01 GENERAL

A. Verify that other trades with related work are complete before installing aluminum access door(s).

B. Mounting surfaces shall be straight and secure; substrates shall be of proper width.

C. Refer to the construction documents, shop drawings and manufacturer's installation instructions.

D. Observe all appropriate OSHA safety guidelines for this work.

2.02 ACCESS DOOR

A. Furnish and install aluminum access hatch as illustrated on Plans. Length denotes hinge side. The vault access door shall be single leaf. The vault access door shall be pre-assembled from the manufacturer.

2.03 MANUFACTURER

A. Product: Type J-5AL.

The BILCO Company
P. O. Box 1203
New Haven, CT 06505
1-203-934-6363
1-203-933-8478 - FAX
Web: www.bilco.com

East Jordan Iron Works, Inc.
301 Spring Street
P. O. Box 434
East Jordan, MI 49727
1-800-874-4100
1-231-536-4458, FAX
Web: www.ejin.com

B. Performance Characteristics:

1. Cover: Shall be reinforced to support a minimum live load of 300 PSF with a maximum deflection of 1/150th of the span.

2. Operation of the cover shall be smooth and easy with controlled operation throughout the entire arc of opening and closing.

3. Operation of the cover shall not be affected by temperature.

4. Entire door, including all hardware components, shall be highly corrosion resistant. Please consult the manufacturer when doors are to be installed in unusually harsh environments or extremely corrosive conditions.

C. Cover: Shall be ¼ inch aluminum diamond pattern.

D. Frame: Channel frame shall be ¼ inch extruded aluminum with bend down anchor tabs around the perimeter. A continuous EPDM gasket shall be mechanically attached to the aluminum frame to create a barrier around the entire perimeter of the cover and significantly reduce the amount of dirt and debris that may enter the channel frame.

E. Hinges: Shall be specifically designed for horizontal installation and shall be through bolted to the cover with tamperproof Type 316 stainless steel lock bolts and shall be through bolted to the frame with Type 316 stainless steel bolts and locknuts.

F. Lifting Mechanisms: Manufacturer shall provide the required number and size of compression spring operators enclosed in telescopic tubes to provide, smooth, easy, and controlled cover operation throughout the entire arc of opening and to act as a check in retarding downward motion of the cover when closing. The upper tube shall be the outer tube to prevent accumulation of moisture, grit and debris inside the lower tube assembly. The lower tube shall interlock with a flanged support shoe fastened to a formed ¼ inch gusset support plate.

G. A removable exterior turn/lift handle with a spring loaded ball detent shall be provided to open the cover and the latch release shall be protected by a flush, gasketed, removable screw plug.

H. Hardware:

1. Hinges: Heavy forged aluminum hinges, each having a minimum ¼ inch diameter Type 316 stainless steel pin, shall be provided and shall pivot so the cover does not protrude into the channel frame.

2. Cover shall be equipped with a hold open arm which automatically locks the cover in the open position.

3. Cover shall be fitted with the required number and size of compression spring operators. Springs shall have an elecrocoated acrylic finish. Spring tubes shall be constructed of a reinforced nylon 6/6 based engineered composite material.

4. A Type 316 stainless steel snap lock with fixed handle shall be mounted on the underside of the cover.

5. Hardware: Shall be Type 316 stainless steel.

6. Finishes: Factory finish shall be mill finish aluminum with bituminous coating applied to the exterior of the frame.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Submit product design drawings for review and approval to the Engineer before fabrication.

B. The Contractor shall check as-built conditions and verify the manufacturer's aluminum access hatch details for accuracy to fit the application prior to fabrication. The Contractor shall comply with the aluminum access hatch manufacturer's installation instruction.

C. The Contractor shall furnish mechanical fasteners consistent with the aluminum access door manufacturer's instructions.

3.02 INSPECTION

A. Verify that the vault access door installation will not disrupt other trades. Verify that the substrate is dry, clean, and free of foreign matter. Report and correct defects prior to any installation.

END OF SECTION 13480

SECTION 15615 - VALVES

PART 1 - GENERAL

1.01 DESCRIPTION

A. The Contractor shall provide all tools, supplies, materials, equipment, and labor necessary for furnishing, epoxy coating, installing, adjusting, and testing of all valves, check valves, combination air and vacuum release valves and appurtenant work, complete and operable, in accordance with the requirements of the Contract Documents. Where buried valves are illustrated on the Plans, the Contractor shall furnish and install valve boxes to grade, with covers, extensions, and position indicators.

B. The provisions of this Section shall apply to all valves and valve operators specified in the various Sections of Divisions 2, 13, 15 and 17 of these Specifications except where otherwise specified in the Contract Documents. Valves and operators in particular locations may require a combination of units, sensors, limit switches, and controls specified in other sections of these Specifications.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Divisions 2 and 15, applicable sections, Pipe, Fittings, and Valves

B. Section 09900 - Protective Coatings

C. Division 16 - Electrical, applicable sections

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Comply with the reference specifications of the General Requirements.

B. Comply with the current provisions of the following Codes and Standards.

ANSI B 16.1	Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800
ANSI B 16.5	Pipe Flanges and Flanged Fittings, Steel Nickel Alloy and Other Special Alloys
ANSI/ASME B 1.20.1	General Purpose Pipe Threads (inch)
ASTM A 36	Specification for Structural Steel
ASTM A 48	Specification for Gray Iron Castings
ASTM A 126	Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A 536	Specification for Ductile Iron Castings
ASTM B 61	Specification for Steam or Valve Bronze Castings
ASTM B 62	Specification for Composition Bronze or Ounce Metal Castings
ASTM B 148	Specification for Aluminum-Bronze Castings

ASTM B 584	Specification for Copper Alloy Sand Castings or General Applications
ANSI/AWWA C 500	Gate Valves for Water and Sewage Systems
ANSI/AWWA C 504	Rubber-Seated Butterfly Valves
ANSI/AWWA C 506	Backflow Prevention Devices - Reduced Pressure Principle and Double Check Valves Types
ANSI/AWWA C 507	Ball Valves 6 inches through 48 inches
AWWA C 508	Swing-Check Valves for Waterworks Service, 2 inches Through 24 inches NPS
ANSI/AWWA C 509	Resilient-Seated Gate Valves for Water and Sewage Systems
AWWA C 550	Protective Interior Coatings for Valves and Hydrants
SSPC-SP-5	White Metal Blast Cleaning
MSS-SP-70	Manufacturers Standardization Society of the Valve and Fitting Industry; Cast Iron Gate Valves. Flanged and Threaded Ends
NSF / ANSI 61:	Drinking Water System Components – Health Effects

1.04 CONTRACTOR SUBMITTALS

A. Submittals shall be made in accordance with General Requirements. In addition to product information, the Contractor shall submit for approval lay-out drawings showing valve locations within the piping system, supports, and identification numbers.

B. The following submittals and specific information shall be provided.

1. Shop Drawings: Shop drawings of all valves and operators including associated wiring diagrams and electrical data, shall be furnished as specified in General Requirements. Submit for approval the following:

a. Manufacturer's literature, illustrations, paint certifications, specifications, detailed drawings, data and descriptive literature on all valves and appurtenances.

b. Deviations from Contract Documents

c. Engineering data including dimensions, materials, size and weight.

d. Fabrication, assembly and installation drawings.

e. CV values, head loss curves, and as required, calculations.

f. Special tools list.

2. Valve Labeling: The Contractor shall submit a schedule of valves to be labeled indicating in each case the valve location and the proposed wording for the label. Complete nameplate data of valves and actuators is required.

3. Operation and Maintenance Manuals:

   a. Submit complete installation, operation and maintenance manuals including test reports, maintenance data and schedules, description of operation, and spare parts information.

   b. Furnish Operation and Maintenance Manuals in conformance with the requirements of the General Requirements.

4. Shop Tests: Hydrostatic tests shall be performed, when required by the valve specifications included herein.

5. Certificates: Where specified or otherwise required by Engineer, submit Test Certificates and Certificates of Compliance with AWWA standards and other specifications, especially where it concerns the suitability of the materials of construction for the particular application.

1.05 QUALITY ASSURANCE

A. Valve Testing: Valves shall be shop tested per manufacturer's recommendations and applicable AWWA/ANSI specifications prior to shipment. Manufacturer's certification that valves have been shop tested shall be submitted for approval 30 days prior to scheduled shipment.

B. Bronze Parts: Where specified, all interior bronze parts of valves shall conform to the requirements of ASTM B 62, or, where not subject to dezincification, to ASTM B 584.

C. Shop Inspection: Shop inspection of valve construction, testing and coating shall be witnessed and approved by the ENGINEER. All valves will be shop inspected unless otherwise waived in writing by the Engineer.

D. The Contractor shall demonstrate that each valve installed as a part of a piping system will operate under field conditions in a manner consistent with the design of the system. All testing of valves shall be witnessed and approved by the Engineer.

E. For all pneumatic, hydraulic, and electric motor operators and controls, it shall be the responsibility of the Contractor to provide a qualified representative of the valve manufacturer to perform all field adjustments to set operator limit switches for the required functions. The cost of providing a qualified representative of the valve manufacturer for field adjustments shall be included in the Contractor’s bid. All wiring of motor operators shall be identified with a unique number unlike any other wiring identification. It is the responsibility of the Contractor to coordinate the requirements of this section with those involving both specifications of Division 16, "Electrical" and Division 17, "Instrumentation."

F. All adjustments, calibration, and/or testing shall be done in the presence of the Engineer.

1.06 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver materials to the site to ensure uninterrupted progress of the Work. Deliver anchorage devices, which are to be embedded in cast-in-place concrete, in ample time to not delay the Work.

B. All boxes, crates and packages shall be inspected by Contractor upon delivery to the site. Contractor shall notify Engineer if any loss or damage exists to equipment or components. Replace loss and repair damage to new condition, in accordance with manufacturer's instructions.

C. Store materials to permit easy access for inspection and identification. Keep all material off the ground, using pallets, platforms or other supports. Protect steel members and packaged materials from corrosion and deterioration.

D. Provide full-face protectors of waterproof material fastened to each side of the valve body to protect joints and the valve interior.

PART 2 - PRODUCTS

2.01 GENERAL VALVE REQUIREMENTS

A. General: The Contractor shall furnish all valves, operators, actuators, valve-operating units, stem extensions, and other accessories as shown or specified. All valves shall have the name of the manufacturer and the site of the valve cast on the body or bonnet or shown on a permanently attached plate in raised letters. All valves shall be new and of current manufacture. All valves, 6 inch and larger, shall have operators with position indicators. Where buried, these valves shall be provided with valve boxes and covers containing position indicators, and valve extensions.

B. Valve Flanges: The flanges of valves shall be in accordance with Divisions 2 and 15.

C. Valve Stems: Except where otherwise specified, valves with motorized operators shall have stems conforming to ASTM A 276 Type 316 stainless steel with minimum tensile strength of 95,000 psi, and a minimum yield point of 75,000 PSI, and elongation of 25% in 2 inches. Manually operated valves shall have silicon-bronze stems conforming to ASTM B 584-875, having minimum tensile strength of 60,000 PSI, a minimum yield point of 24,000 PSI, and elongation of 16% in 2 inches. Where subject to dezincification, manually operated valve stems shall be of bronze conforming to ASTM B 62, containing no more than 5% zinc, nor more than 2% aluminum.

D. Protective Coating: Except where otherwise specified, ferrous surfaces, exclusive of stainless steel surfaces, in the water passages of all valves 4 inch and larger, as well as the exterior surfaces of all submerged, buried or aboveground valves and operators, shall be fusion bonded epoxy. Flange faces of valves shall not be coated. The valve manufacturer shall certify in writing that such coating has been applied and tested in the manufacturing plant prior to shipment, in accordance with these Specifications.

E. Valve Operators:

1. Valve operators shall be provided for specific valves as required by the specification section.

2. When one, or more, underground valve is installed, an adjustable valve key shall be provided to the Owner.

G. Nuts and Bolts: All nuts and bolts on valve flanges and supports shall be coated with a flouropolymer as manufactured by Tripac (Tripac 2000 Blue), or an approved equal. All bolts on valve bonnets and exterior valve hardware shall be Type 316 stainless steel.

2.02 RESILIENT SEATED GATE VALVES

Resilient seated gate valves shall conform to AWWA C 509, latest edition. The wedge shall be fully encapsulated in the elastomer, including the guides. The brass stem nut shall be rigidly enclosed in the wedge to maintain alignment. The valve body shall be composed of ductile iron.

The stem shall have two (2) O-rings and a wiper above the collar and one (1) O-ring below the collar. Stem seals must be replaceable with the valve under pressure.

The stem material shall be standard bronze. Stainless steel (ANSI-420) shall also be acceptable for use as an alternative.

The waterway shall be full size to allow for tapping use; no cavities or depressions shall be permitted in the seat area.

Valve body and bonnet shall be electrostatically applied, fusion bonded, epoxy coated both inside and out by the valve manufacturer. The coating shall meet the requirements of AWWA C 550, latest edition. Coating shall be applied only at the valve manufacturer's facilities. Exterior hardware shall be composed of Type 316 stainless steel.

The bonnet bolts shall not be exposed to the environment.

O-ring style seals shall be used as gaskets on the bonnet and on the stuffing box. The below grade valves shall be supplied with a standard 2 inch operating nut. All valves shall be wrapped with a polyethylene material.

Available Manufacturers: Subject to compliance with requirements, manufacturers offering resilient wedge gates valves which may be incorporated into the work are:

a. AFC
b. Clow
c. M&H Valve Company
d. Mueller
e. Or Equal.

2.03 BUTTERFLY VALVES

A. General:

All butterfly valves shall be of the rubber-seated tight-closing type. They shall meet or exceed AWWA Standard C 504.

Both valve ends shall be mechanical-joint (or other, as available) per AWWA Standard C 111. Accessories (bolts, glands and gaskets) shall be supplied by the valve manufacturer.

Available Manufacturers: Subject to compliance with requirements, manufacturers offering butterfly valves which may be incorporated into the work are:

a. Bray
b. Pratt
c. Dezurik
d. Clow
e. Or Equal.

All valves must use full AWWA C 504 Class 150B valve shaft diameter, and full Class 150B underground-service-operator torque rating throughout entire travel, to provide capability for operation in emergency service. All valves shall be NSF approved.

B. Valve:

Valve body shall be composed of ductile iron with 18-8 Type 304 stainless steel body seat. Valve vane shall be ductile iron, having rubber seat mechanically secured with an integral 18-8 stainless steel clamp ring and 18-8 stainless steel self-locked screws.

Rubber seat shall be a full-circle 360 degree seat not penetrated by the valve shaft. For valves 4" - 12", the valve shaft shall be one piece, extending full size through the entire valve. Valve shaft shall be 304 stainless steel. Packing shall be O-ring cartridge designed for permanent duty in underground service. For 14 inches and larger valve shaft shall be 18-8 stainless steel stub shaft design keyed to the vane with stainless steel taper pins.

Body Type: All butterfly valves shall be of the rubber-seated tight-closing type. They shall meet or exceed AWWA Standard C 504.

Valve ends shall be: As noted in the Plans.

Wafer: Suitable for installation between 125# or 150# ASA flanges (available 4 inch through 20 inch).

Flanged: Short body valves per Table 2 of AWWA Spec C 504. Flanges shall be 125# ANSI (available all sizes). Also flanged by MJ in 6 inch, 8 inch and 16 inch sizes.

Mechanical Joint: Both ends of valve shall be "MJ" per AWWA C 111. "MJ" accessories (bolts, glands, gaskets) must be supplied by valve manufacturer (available all sizes - also flanged by MJ in 6 inch, 8 inch, 12 inch and 16 inch sizes). Both ends of valve shall be "MJ" per AWWA C111. "MJ" accessories (bolts, glands, gaskets) shall be supplied by valve manufacturer (available all sizes - also flanged by MJ in 6 inch, 8 inch, 12 inch and 16 inch sizes).

C. Operator:

Valve operator shall be of the traveling-nut type, sealed, gasketed, and lubricated for underground service. It shall be capable of withstanding an overload input torque of 450 ft. lbs at full-open or full-closed position without damage to the valve or valve operator. It shall be designed for submergence in water to 25 feet head pressure for up to 72 hours.

Valve shall be capable of easy closure by one man using standard valve key, even under emergency line-break conditions as severe as those that would cause a valve maximum opening torque requirement of as much as two times AWWA Class 150B.

All valves shall open left (clockwise to close), and be equipped with 2 inch AWWA operating nut.

Crank, Handwheel or Chainwheel: All manual operators for service other than underground shall have position indicator and shall be totally enclosed and permanently lubricated. In any event, a maximum pull of 80 pounds on the crank or wheel shall produce full Table 1 output torque throughout entire travel. Operators shall full-closed positions without damage to valve or operator. Operators shall be of the "traveling-nut" type. All valves shall open left (clockwise to close).

Cylinder: Cylinder operator shall be of the base mounted configuration. Cylinder barrel shall be of molybdenum-disulfide lined glass fiber reinforced epoxy tubing, to provide a corrosion-free, self-lubricated high strength barrel. Rod seal shall be of urethane, molybdenum-disulfide filled, to provide a self-lubricated, long life seal.

Piston rod shall be of hard chromium plated 18-8 stainless steel, and shall be top and bottom guided in a heavy cast iron mechanism housing for positive alignment. Guiding shall be accomplished by bronze bearings at ends of housing straddling all side loads improved in operation. Entire operator including piston rod shall be fully enclosed. Operator shall produce full AWWA Standard C 504 Table 1 output torque throughout entire travel for Class (25A) (25B) (75B) (150B) with a minimum supply pressure of PSI (water) (air) (oil).

Electric Valve Actuators: Actuators shall be provided as called out in the improvement Plans. The actuator shall be compact and low profile to minimize space requirements. The actuator shall operate over 90º. The actuator shall provide easy access for field wiring and adjustment. The actuator shall be built to withstand line vibration and shock without failure.

The enclosure shall be die-cast aluminum for environmental protection. The waterproof enclosure shall be certified to UL, CSA and CE NEMA 4 waterproof standards. The waterproof/explosion proof enclosure shall be certified to UL NEMA 4 hazardous locations. The enclosure shall be provided with captive cover bolts to prevent loss of cover bolts when cover is removed. The enclosure shall have two conduit connections (one for power wiring and one for control signal wiring) in either NPT or metric threads as specified. The actuator enclosure shall be provided with a high visibility valve position display prominently labeled and color coded to indicate the valve position throughout the full range of travel.

The motor shall be a single phase, permanent split capacitor reversible induction type with Class F or better insulation. The motor shall contain a built-in UL approved automatic reset thermal overload protector set at 275º F (135ºC) embedded in the motor windings. Motors shall be 24 VAC, 120 VAC 50/60 Hz or 240 VAC 50/60 Hz as specified on the Electrical and or Instrumentation Plans.

The actuator shall have a self-locking gear train system consisting of a worm and worm gear output drive mechanism which will hold the valve in the desired position without the need for an electro-mechanical braking system. The spur gear train shall have precision cut multi-staged gears which will withstand locked rotor conditions and are permanently lubricated at the factory.

Mechanical stainless-steel travel stops shall be provided and located outside the actuator enclosure for ease of adjustment. Stainless steel lock nuts to hold the travel stops in position and o-ring seals for waterproof protection shall be provided. The mechanical travel stops shall be capable of limiting the travel of the actuator in either direction from full closed to full open.

The actuator shall be equipped with a manual override handwheel to rotate the valve without electrical power. The manual override system shall ensure positive and efficient manual operation without the use of extra tools or levers.

An automatic power cutout switch shall be provided to cut power to the motor when the actuator manual override is engaged. This cutout shall also function as a safety emergency power shutdown device and shall be accessible from outside the actuator enclosure.

All travel switches shall be:

Single Pole, Double Throw Form C Type
UL Listed and CSA Approved
10A at 125/250 VAC and 1/2A at 125 VDC

The actuator switches shall be pre-wired to a terminal block for ease of access and all internal wiring shall range from 12-22 AWG. The travel limit switches shall limit the actuator travel in both the open and closed direction of travel. Cams for each travel limit switch shall be infinitely adjustable by finger touch or screw driver.

Actuators shall be designed for electric operation for the following service conditions:

Temperature ranges of -40ºF (-40ºC) to +150ºF (+65ºC)
Duty Cycle: 25% for Intermittent Operation
100% for Continuous Operation

All actuators shall be factory tested to ensure proper operation.

All actuators shall mount directly to the valve mounting flange and stem without the need for any brackets or couplings.

The actuator shall be designed to accept any of the following optional accessories if specified during the submittal review process:

A. Torque Limiting System:
- Shall include a 2 SPDT mechanical switches and 2 factory calibrated adjusting screws.
- The switches, in response to a predetermined load on the actuator output shaft, shall interrupt power to the motor.
- The switches shall operate at any point and in both directions of actuator level.

B. Heater:
- Shall include a self-regulating temperature control to prevent condensation build-up.
- Shall be pre-wired to the terminal block for ease of connection to external source.
- Rated output shall be 15W at 120 or 220 VAC.

C. Microprocessor Servo:
- Shall provide precise modulating control of the valve position in response to an analog input signal.
- Shall have an analog output signal proportional to the actual valve position and the signal shall be configurable to either current or voltage output.
- Voltage spike protection shall be provide on all input terminals.
- Independent adjustments shall be provided for Deadband and for both open and closed Speed Control of the actuator.
- Input signals shall be:
  4-20 mADC 250 Ohm Input Impedance
  0-10 VDC 2.1k Ohm Input Impedance
  2-10 VDC
  10k Ohm or great potentiometer

- Calibration shall be accomplished by pressing a single button to initiate the calibration routine.
- Control characteristics shall be linear and duty cycle shall be 100%.
- Internal feedback shall be by means of a 10k Ohm potentiometer.
- Retransmission outputs shall be:
  4-20 mADC
  0-5 VDC
  0-10 VDC
  2-10 VDC
- Separate Speed Control adjustments shall be provided for adjustment of open and close travel speeds.
- Inputs for the control box, handwheel, LED status indicators and self-diagnostic capability shall also be provided.
- DeviceNet Servos shall also be available if specified.

D. Local Control Station:

- For local electrical operation of the actuator.
- Shall flush mount to the actuator and include:
  -a local/off/remote control switch
  -an open/stop/close switch
  -two lights which indicate open and closed valve position
- Enclosure shall be aluminum and waterproof (NEMA 4, 4X, IP 65)

D. Coating:

Standard coating shall be universal primer. Coating shall be applied to entire valve body and vane before final assembly.

Valve body shall be electrostatically applied, fusion bonded, epoxy coated to all surfaces of valve body and vane to an average minimum film thickness of 5 mils, conforming to AWWA C 550 Standard. Coating shall be applied only at the valve manufacturer's facilities. Exterior valve hardware shall be composed of Type 316 stainless steel hardware for butterfly valve flanges shall consist of flouropolymer coated hardware as manufactured by Tripac (Tripac 2000 Blue) or an approved equal.

E. Tests:

All valves shall be tested bottle-tight at rated working pressure by the manufacturer as follows:

4" through 12"	200 PSI
14" Up	150 PSI

In addition, a hydrostatic test with vane partially open shall be given to the assembled valve as follows:

4"	400 PSI
14" Up	300 PSI

2.04 SWING CHECK VALVES

The check valves shall be manufactured of gray cast iron in conformance with ASTM A 126 Grade B. The swing check valves shall comply with AWWA C 508, latest revision. The check valve shall be provided with flanges in accordance with ANSI B 16.1, Class 125.

The valve design shall be full flow equal to nominal pipe diameter at all points through the valve. The valve shall be capable of passing 3-inch diameter sphere. The seating surface shall be on a 45-degree angle to minimize disc travel. A threaded port with pipe plug shall be provided on the bottom of the valve to allow for field installation of a backflow actuator, without special tools or removing the valve from the line.

The top access port shall be full size, allowing removal of the disc without removing the valve from the line. The access cover shall be domed in shape to provide flushing action over the disc for operating in lines containing high solids content. A threaded port with plug shall be provided in the access cover to allow for field installation of a mechanical, disc position indicator.

The disc shall be of one-piece construction, precision molded with an integral O-ring type sealing surface and contain alloy steel and nylon reinforcement in the flexible hinge area. The flex portion of the disc shall be warranted for 25 years. Non-slam closing characteristics shall be provided through a short 35-degree disc stroke and a memory disc return action.

The valve body and cover shall be constructed of ductile iron per ASTM A 536 Grade 65-45-12.

The disc shall be precision molded Buna N (NBR), ASTM D 2000-BG.

The exterior and interior of the valve shall be coated with an ANSI/NSF 61 approved fusion bonded epoxy coating.

2.05 SILENT CHECK VALVES

The Silent Check Valve shall be globe style. The check valve shall be the silent operating type that begins to close as the forward flow diminishes and fully closes at zero velocity preventing flow reversal and resultant water hammer.

The valves shall be constructed for potable water service use and shall be certified to NSF/ANSI 61, Drinking Water System Components – Health Effects, and certified to be Lead-Free in accordance with NSF/ANSI 372. The manufacturer shall have a quality management system that is certified to conform with ISO 9001 by an accredited, certifying body. The Globe Style valves shall be supplied with 125- or 150-pound flanges.

The valve design shall incorporate a center guided, spring loaded disc and having a short linear stroke that generates a flow area equal to the nominal valve size. The operation of the valve shall not be affected by the position of the installation. The valve shall be capable of operating in the horizontal or vertical positions with the flow up or down. All component parts shall be field replaceable without the need of special tools. Globe style valves shall be provided with a replaceable guide bushing held in position by the spring. The spring shall be designed to withstand 100,000 cycles without failure and provide a cracking pressure of 0.50 psi. The globe disc shall be concave to the flow direction providing for disc stabilization, maximum strength, and a minimum flow velocity to open the valve. The valve disc and seat shall have a seating surface finish of 16 micro-inch or better to ensure positive seating at all pressures. A resilient seal shall be provided on the seat to provide zero leakage at both high and low pressures without overloading or damaging the seal. The seal design shall provide both a metal to metal and a metal to resilient seal.

The valves shall by hydrostatically tested at 1.5 times their rated cold working pressure (CWP) and seat tested at the valve CWP. The manufacture shall provide the test certificates, dimensional drawings, parts list drawing and operation and maintenance manuals with each valve. The exterior of the valve shall be coated with a universal alkyd primer.

Valve interiors and exteriors shall be coated with an NSF/ANSI 61 certified fusion bonded epoxy in accordance with AWWA C550. The valve body shall be constructed of ASTM A126 Class B Cast Iron. The globe style valve seat and disc shall be ASTM A351 Grade CF8M stainless-steel. The compression spring shall be ASTM A313 Type 316 SS with ground ends.

2.06 VALVE RISER AND VALVE COVER

A 6-inch diameter cast iron valve riser and ductile iron cover shall be placed over each below grade valve. The 6-inch diameter cast iron valve riser and cover shall be manufactured by Star Pipe Products, or an approved equivalent of equal substance and function.

Place an 8 inch deep, 8-inch wide PCC collar concentric with the exterior of the valve extension riser. Place the top of the riser 0.10-feet above the finish grade.

Two (2) 6-foot valve keys for operating of gate valves shall be furnished by the Contractor to the Owner prior to completion of the project.

PART 3 - EXECUTION

3.01 VALVE INSTALLATION

A. General: All valves, operating units, controls, stem extensions, valve boxes, and accessories shall be handled in a manner to prevent any injury to any part of the valve. Valves shall be installed in accordance with the manufacturer's written instructions and as shown and specified. All valves shall be adequately braced to prevent warpage and bending under the intended use. Valves shall be firmly supported to avoid undue stresses on the pipe. All valves shall be installed so that the valve stems are plumb.

B. Access: All valves shall be installed to provide easy access for operation, removal, and maintenance and to avoid conflicts between valve operators and structural members or handrails.

C. Valve Accessories:

1. Where combinations of valves, sensors, switches, and controls are specified, it shall be the responsibility of the Contractor to properly assemble and install these various items so that all systems are compatible and operating properly. The relationship between interrelated items shall be clearly noted on Shop drawing submittals.

2. Valve operators and controls are to be installed where specified and designated on the Plans. The Contractor is responsible for installation of the correct valve operator and control as specified to provide a complete piping system as specified.

D. All valves shall be field tested following installation to demonstrate that the valve operates under field conditions in a manner consistent with the design of the system.

E. All testing of valves shall be witnessed and approved by the Engineer.

F. The Contractor shall demonstrate that each valve operator and control installed as a part of a piping system will operate under field conditions as designed and in the manner for which the operator was specified.

END OF SECTION

SECTION 15707 - CHEMICAL PIPING

PART 1 - GENERAL

1.01 DESCRIPTION

A. It shall be the responsibility of the CONTRACTOR to furnish and install all chemical piping systems specified herein and as illustrated in the Drawings. Each system shall be installed complete with all applicable fittings, hangers, supports, anchors, expansion joints, flexible connections, valves, and accessories to provide a functional system as designed. In addition, all insulation, lining and coating, heat tracing, testing, disinfection, excavation, backfill and encasement shall be the responsibility of the CONTRACTOR.

B. The CONTRACTOR shall provide all tools, equipment, materials, and supplies necessary and shall perform all labor necessary to complete the work specified herein and as illustrated in the Drawings. The CONTRACTOR shall provide any equipment necessary for inspection of and testing of piping systems specified.

C. Piping shown on drawings and specified herein is intended to define the general layout, configuration, routing, required method of support, pipe size and type only. It is the responsibility of the CONTRACTOR to provide a complete system in accordance with the Drawings and requirements set forth herein. All details necessary to provide a complete system as specified herein are the responsibility of the CONTRACTOR. The CONTRACTOR shall provide all spools, spacers, adapters, connectors, and supports necessary to provide a complete and functional system. The CONTRACTOR shall furnish pipe supports, hangers, anchors, etc., in addition to those illustrated on the Drawings, when necessary to provide a system as specified herein. The CONTRACTOR shall provide lay-out drawings of all piping systems prior to installation showing all piping, equipment, accessories, supports, etc.

1.02 RELATED WORK SPECIFIED ELSEWHERE (NOT USED)

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Comply with the reference specifications of the GENERAL REQUIREMENTS.

B. Commercial Standards:

ASTM D1784	Specification for Rigid Polyvinyl Chloride (PVC) Compounds and Chlorinated Polyvinyl Chloride (CPVC).
ASTM D1785	Specification for Polyvinyl Chloride (PVC) Plastic Pipe, Schedules 40, 80 and 120.
ASTM D2467	Specification for Socket-Type Poly Vinyl Chloride (PVC) Plastic PipeFittings, Schedule 80
ASTM D2564	Specification for Solvent Cements for Poly Vinyl Chloride (PVC) Plastic Pipe and Fittings

ASTM D4101	Specification for Polypropylene Injection and Extrusion Materials.
PPI Technical Report TR 3/4	Policies and Procedures for Developing Recommended Hydrostatic Design Stresses for Thermoplastic Pipe Materials
AWWA Manual M23	PVC Pipe - Design and Installation

1.04 CONTRACTOR SUBMITTALS

A. The CONTRACTOR shall complete shop drawings of all chemical piping systems, equipment, accessories, and supports. The shop drawings shall include all necessary dimensions and details on pipe joints, fittings, fitting specials, valves, appurtenances, design calculations, and material lists. The submittals shall include detailed layout, spool, or fabrication drawings which show all pipe spools, spacers, adapters, connectors, fittings, and pipe supports necessary to accommodate the equipment and valves provided in a complete and functional system. The CONTRACTOR shall submit detailed drawings of all systems for approval prior to starting installation. Drawings shall include all dimensions and spacings for pipe joints, fittings, fitting specials, valves, appurtenances, connectors, adapters, supports, hangers, anchors, etc. necessary to provide a complete and functional system as specified herein.

PART 2 - PRODUCTS

2.01 GENERAL

A. All pipes, fittings, and appurtenances shall be furnished as specified herein.

B. Pipe Supports: All pipes shall be adequately supported.

2.02 ~~STAINLESS STEEL CHEMICAL PIPING~~

~~A. Stainless steel piping, fittings and valves shall be provided in accordance with Section 15740: Stainless Steel Pipe, Fittings and Valves.~~

2.03 CHEMICAL PIPING

A. Secondary Containment/Chemical Casing Pipe: Schedule 80 Polyvinyl Chloride (PVC) Pipe and Fittings:

a. Pipe: ASTM D1785, Schedule 80, PVC 1120, with NSF seal.

B. Injection Tubing: Chemical injection piping shall conform to NSF51/61:

1. Material:
   a. High Density Polyethylene (HDPE)
   b. Polytetrafluoroethylene (PTFE)
   c. Viton
   d. Polyvinylidene Fluoride (PVDF)
   e. Ultra-High Molecular Weight Polyethylene (UHMWPE)
1. Tubing: 1/4” Inside Diameter, 1/16” minimum wall thickness
2. Minimum working pressure 151 psi at 73 degrees F.

3. Color: clear, black or natural
4. Solid non-jointed, no splicing allowed

C. All chemical piping shall be installed so that lines are readily accessible for cleaning.

D. Chemical piping bends shall not exceed 45 Degrees.

E. At all exposed changes in direction in chemical piping, elbows shall be provided with extra threaded openings plugged to facilitate cleaning.

1. Thread tape or thread sealer shall be applied to the threads of all plugs to facilitate ease of removal.

F. The assembled double-containment system secondary pipe shall be constructed of poly-vinyl chloride (PVC) pipe for outdoor applications. These systems shall be joined to provide a minimum of 150 psig at 73^0 F leak-free seals.

1. All assembled double-containment piping and fittings shall be supplied by the same source to insure material and system compatibility. The carrier and containment pipe and fittings shall be Schedule 80 and shall be factory assembled with centralizing and anchoring devices installed.

G. The co-extruded one-piece double containment pipe system shall conform to the following:

1. Material: Pipe and fittings shall be schedule 80 pvc type.

2. Pipe and Fittings - Construction: Pipe shall be co-extruded one piece double containment pipe. The primary pipe shall be integral with the secondary pipe via connecting ribs which are continuous down the entire length of each section of pipe. Fittings shall be a molded unitary double wall fitting. Permanent alignment of the inner and outer fittings shall be maintained via molded-in ribs.

3. Factory Welded Joints: Joining shall be by means of solvent cement.

4. Installation: Installation shall be in accordance with the drawings, the manufacturer's recommendations. The entire installation shall be installed in proper alignment and free of stress.

5. Testing: The system shall be tested in accordance with the manufacturer's recommendations.

H. Secondary containment shall be adequately sized to contain 100 percent of the volume of the service pipe.

I. Drip shields shall be installed beneath all elevated chemical piping in areas subject to pedestrian traffic to contain and transport leakage to an approved disposal area.

PART 3 - EXECUTION

3.01 GENERAL

A. All piping and appurtenances shall be installed in accordance with the requirements of all applicable and related Divisions of these specifications.

B. Any deviation from lines, grades, or elevations shown on the Contract Drawings must be approved in writing by the Owner's Representative.

3.02 CUTTING PIPE

A. Cutting of carrier pipe shall be done in a neat manner, without damage to the pipe, pipe lining, or pipe coating.

B. Cuts shall be smooth, straight, and at right angles to the pipe axis.

C. Splicing of the chemical feed tubing is not permitted.

3.03 CLEANING

A. The interior of all pipe and fittings shall be thoroughly cleaned of all foreign matter prior to installation, and shall be kept clean until the work has been accepted.

B. Before jointing, all joint contact surfaces shall be wire brushed, wiped clean, and kept clean until the jointing is completed.

C. Flange faces shall be wire brushed and cleaned to remove all oil, grease, loose primer, mill scale, or any other foreign matter which could effect the proper seating of the gasket.

D. Prior to testing, pipe shall be thoroughly cleaned and/or purged in accordance with these specifications.

3.04 PIPE SLEEVES

A. Unless otherwise specified or indicated on the contract drawings, pipes passing through concrete or masonry shall be installed through Type 316 stainless steel sleeves installed before concrete is placed or masonry is laid.

B. The CONTRACTOR shall be responsible for coordinating the installation of sleeves for all piping.

3.05 PIPE INSTALLATION

A. All piping shall be installed as specified, as indicated on the contract drawings and in a manner acceptable to the Owner's Representative.

B. The CONTRACTOR shall provide pipe cut from measurements made at the job site, and not from the contract drawings.

C. Provisions shall be made in laying out all piping throughout to provide for expansion and contraction.

D. Piping shall not obstruct openings or passageways.

E. Pressure piping shall not be installed above electrical panels or cabinets.

F. All piping serving metering equipment shall be uniformly graded so that air traps are eliminated and complete venting is provided.

G. Taps for pressure gage connections on the suction and discharge sides of pumping units shall be provided with a nipple and an approved shutoff valve.

1. Drilling and tapping of pipe walls for installation of pressure gages or switches will not be permitted.

2. Taps shall be provided by factory threaded taps or a factory welded boss.

H. All branch connections in horizontal runs of air, gas, or stream piping shall be made from the top of the pipe.

3.06 PIPE JOINTS

A. Pipe joints shall be provided as recommended by the manufacturer.

B. Solvent cement connection for sodium hypochlorite PVC pipeline shall be per ASTM D 2564.

END OF SECTION 15707

SECTION 15740 - STAINLESS STEEL PIPE, FITTINGS AND VALVES

PART 1 - GENERAL

1.01 DESCRIPTION

A. The Contractor shall furnish all tools, equipment, materials, and supplies and shall perform all labor required to complete the work as illustrated on the Plans and specified herein.

B. This Section covers furnishing and installing stainless steel pipeline, fittings, flanges, and valves, complete, in place, in accordance with the requirements of the Contract Documents.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Division 2: As applicable

B. Section 15707 - Chemical Piping

C. Section 09800 - Protective Coatings

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Comply with the reference specifications of the General Requirements.

B. Comply with the current provisions of the following Codes and Standards.

1. Commercial Standards:

ANSI/ASME B 16.5	Pipe Flanges and Flanged Fittings NPS ½ inch through NPS 24 inch.
ANSI/ASME B 16.9	Factory-Made Wrought Buttwelding Fittings
ANSI//ASME B 16.11	Forged Fittings, Socket-Welding and Threaded
ANSI/ASME B 16.47	Large Diameter Steel Flanges NPS 26-Inch through NPS 60-Inch
ANSI/ASME B 18.22.1	Plain Washers
ANSI/ASME B 31.1	Power Piping
ANSI/AWWA C 606	Grooved and Shouldered Joints
ASTM A 182	Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service
ASTM A 193	Specification for Alloy-Steel and Stainless Steel Bolting Materials for High

	Temperature or High Pressure Service and Other Special Purpose Applications
ASTM A 194	Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both
ASTM A 269	Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service
ASTM A 312	Specification for Seamless and Welded Austenitic Stainless Steel Pipe
ASTM A 351	Specification for Castings, Austenitic, for Pressure-Containing Parts
ASTM A 403	Specification for Wrought Austenitic Stainless Steel Piping Fittings
ASTM F 1387	Standard Specification for Performance of Piping and Tubing Mechanically Attached Fittings
NSF / ANSI 61	Drinking Water System Components – Health Effects

1.04 CONTRACTOR SUBMITTALS

A. Shop Drawings: The Contractor shall submit shop drawings of pipe, fittings, flanges, valves, and appurtenances.

B. Certifications: The Contractor shall furnish a certified affidavit of compliance for all pipe and other products or materials furnished under this Section of the Specifications, as specified in the referenced standards and the following supplemental requirements:

1. Hydrostatic proof test reports.

2. Sustained pressure test reports.

3. Burst strength test reports.

D. All expenses incurred in making samples for certification of tests shall be borne by the Contractor.

1.05 QUALITY ASSURANCE

A. The Contractor is to comply with the provisions of this specification and all other applicable sections of this specification, standards, codes, and regulations.

B. In addition to any other markings specified herein, each length of pipe and each special section provided under this specification shall be legibly marked by paint stenciling, die stamping, or hot-roll marking to show the following:

1. Manufacturer's name or mark.

2. Size and weight of the pipe or special section.

3. Type of steel from which the pipe or if applicable special section was made.

C. Tests: Except as modified herein, all materials used in the manufacture of the pipe shall be tested in accordance with the requirements of this Section of the Specifications, as specified in the referenced standards, as applicable.

D. The Contractor shall perform said material tests in accordance with the requirements of the Contract Documents. The Engineer shall have the right to witness all testing conducted by the Contractor provided that the Contractor's schedule is not delayed for the convenience of the Engineer.

E. In addition to those tests specifically required, the Engineer may request additional samples of any material for testing by the Engineer. The additional samples shall be furnished at no additional cost to the Owner.

PART 2 - PRODUCTS

2.01 GENERAL

A. All pipes, fittings, flanges, and valves shall be carefully examined for cracks and other defects prior to shipment. All defective pipes, fittings, flanges, and valves shall be rejected and replaced.

B. All pipes and equipment shall be supported.

C. Coating: All underground pipes, fittings, flanges, and valves shall be provided with coating in accordance with Section 09800 - Protective Coatings.

D. Stainless steel piping systems shall have design pressure limit of 150 psig and temperature limit of 300 degree F, unless otherwise noted.

E. Insulating connections: Protection shall be provided at all dissimilar metal connections.

1. General: Insulating gaskets, sleeves, washers, bushings, unions, couplings, or flanges, as appropriate, shall be used for joining pipes of dissimilar metals, and for piping systems where corrosion control and cathodic protection are required regardless of whether or not illustrated on the Plans.

2. Material: Insulating connections shall be in accordance with the manufacturer's requirements.

2.02 PIPE AND TUBING

A. Pipe:

1. Sizes 1/2" - 2 1/2"

a. Schedule 40S, Stainless Steel ASTM A 312 Type 316L, Seamless, Plain Ends.

b. Pipe Nipples: Schedule 40S, Stainless Steel ASTM A 312 Type 316L, Seamless, Plain Ends or Threaded Ends.

c. Swage Nipples: Schedule 40S, Stainless Steel ASTM A 403 Grade WP316L, Seamless, Plain Ends or Threaded Ends.

2. Sizes 3" - 24":

a. Schedule 40S, Stainless Steel ASTM A 312 Type 316L, Seamless, Beveled Ends.

3. Sizes 26" - 36"

a. 0.312" pipe wall thickness, Stainless Steel ASTM A 312 Type 316L, Seamless, Beveled Ends.

B. Tubing:

1. Sizes 1/4" - 3/8":

a. 0.065" tube wall thickness, Fully Annealed, Stainless Steel ASTM A 269 Grade TP316L, Seamless.

2. Sizes 1/2" - 7/8"

a. 0.083" tube wall thickness, Fully Annealed, Stainless Steel ASTM A 269 Grade TP316L, Seamless.

3. Sizes 1" - 1 1/2":

a. 0.120" tube wall thickness, Fully Annealed, Stainless Steel ASTM A 269 Grade TP316L, Seamless.

2.03 FITTINGS

A. Threaded Fittings:

1. Sizes 1/2” - 2 1/2”:

a. Class 3000 ANSI/ASME B 16.11, Stainless Steel ASTM A 182 Type 316, Threaded.

B. Socket Weld Fittings:

1. Sizes 1/2" - 2 1/2":

a. Class 3000 ANSI/ASME B 16.11, Stainless Steel ASTM A 182 Type 316L, Socket weld.

C. Butt Weld Fittings:

1. Sizes 3" - 24":

a. Schedule 40S, ANSI/ASME B 16.9, Stainless Steel ASTM A 403 Grade WP316L, Seamless, Butt Weld.

2. Sizes 26" - 36":

a. 0.312" pipe wall thickness ANSI/ASME B 16.9, Stainless Steel ASTM A 403 Grade WP316L, Seamless, Butt weld.

D. Pipe Couplings:

1. Grooved Couplings, sizes 3/4" - 18", for stainless steel pipe shall be per ANSI/AWWA C 606 and shall be furnished for use on radius cut or standard roll grooved pipe ends. Couplings shall be Type 316 Stainless Steel ASTM A 351, Grade CF8M.

2. Gaskets: Materials of gaskets shall be Viton.

3. Fasteners: All bolts, nuts, and washers shall be made of Type 316 stainless steel.

E. Tube Fittings:

1. Sizes 1/4" - 1 1/2":

a. Compression Type, 316 Stainless Steel with 316 Stainless Steel Ferrules.

2.04 PIPE FLANGES

A. Flanges:

1. Sizes 1/2" - 2 1/2":

a. Class 300 ANSI/ASME B 16.5, Stainless Steel ASTM A 182 Grade F316L, Raised Face, Socketweld, Schedule 40S Bore.

2. Sizes 3" - 24":

a. Class 300 ANSI/ASME B 16.5, Stainless Steel ASTM A 182 Grade F316L, Raised Face, Weldneck, Schedule 40S Bore.

3. Sizes 26" - 36":

a. Class 300 ANSI/ASME B 16.47, Stainless Steel ASTM A 182 Grade F316L, Raised Face, Weldneck, Schedule 40S Bore.

B. Blinds Flanges

1. Sizes 1/2" - 24":

a. Class 300 as needed ANSI/ASME B 16.5, Stainless Steel ASTM A 182 Grade F316L, Raised Face.

2. Sizes 26" - 36":

a. Class 300 as needed ANSI/ASME B 16.47, Stainless Steel ASTM A 182 Grade F316L, Raised Face.

C. Orifice Flanges

1. Sizes 1" - 24":

a. Class 300 ANSI/ASME B 16.5 with 1/2" Screwed Taps, Stainless Steel ASTM A 182 Grade F316L, Raised Face, Weldneck, or Schedule 40 Bore**.**

b. Mating Flanges shall be Class 300 ANSI/ASME B 16.5, Stainless Steel ASTM A 182 Grade F316L, Raised Face, Weldneck, Schedule 40S Bore.

D. Gaskets:

1. Sizes 1/2" - 24":

a. Spiral Wound Type, 316 Stainless Steel with Graphite Filler, 1/8" Thick Centering Ring, drilling per Class 150 ANSI/ASME B 16.5.

2. Sizes 26" - 36":

a. Spiral Wound Type, 316 Stainless Steel with Graphite Filler, 1/8" Thick Centering Ring, drilling per Class 150 ANSI/ASME B 16.47.

E. Bolts:

1. Studs: 16 Stainless Steel ASTM 193 Grade B8M.

2. Nuts: 316 Stainless steel ASTM 194 Grade 8M.

3. Washers: 316 Stainless Steel ANSI B 18.22.1.

4. Assemble with anti-seize compound.

2.05 VALVES

A. General:

1. All valves shall be furnished and installed as illustrated on the Plans.

2. Valves with pneumatic, hydraulic, and electric motor operators and controls shall be in accordance with Division 17.

3. Valves with manual operators shall be as specified herein.

B. Fasteners: All bolts, nuts, and washers shall be made of Type 316 stainless steel.

C. Ball Valves:

1. Sizes 1/2" - 2 1/2":

a.	Class:	900 PSI, Screwed.
b.	Type:	Full port.
c.	Body:	316 Stainless Steel ASTM A 351.
d.	Ball:	316 Stainless Steel.
e.	Seat:	Reinforced PTFE Fire Safe.
f.	Stem:	316 Stainless Steel.
g.	Operator:	Manual, Lever.

2. Sizes 3" - 4":

a.	Class:	150 psi, 150 Raised Face Flanged.
b.	Type:	Full port.
c.	Body:	316 Stainless Steel ASTM A 351.
d.	Ball:	316 Stainless Steel.
e.	Seat:	Reinforced PTFE Fire Safe.
f.	Stem:	316 Stainless Steel.
g.	Operator:	Manual, Lever.

D. Butterfly Valves:

1. Sizes 3" - 6":

a.	Class:	150 PSI, 150 Raised Face.

b. Type: Lug style, High Performance Bubble-Tight Shutoff.

c. Body: 316 Stainless Steel ASTM A 351.

d. Disc: 316 Stainless Steel ASTM A 351.

e. B/U Ring: Viton.

f. Seals: PTFE.

g. Shaft: 316 Stainless Steel.

h. Operator: Manual, Lever.

2. Sizes 8" - 36":

a. Class: 150 PSI, 150 Raised Face.

b. Type: Lug style, High Performance Bubble-Tight Shutoff.

c. Body: 316 Stainless Steel ASTM A 351.

d. Disc: 316 Stainless Steel ASTM A 351.

e. B/U Ring: Viton.

f. Seals: PTFE.

g. Shaft: 316 Stainless Steel.

h. Operator: Manual, Worm gear with handwheel.

E. Check Valves:

1. Sizes 1/2" - 2 1/2":

a. Class: 800 PSI, Socket weld.

b. Type: Horizontal, Piston Lift

c. Body: 316L Stainless Steel ASTM A 182.

d. Trim: 316 Stainless Steel.

e. Bonnet: Bolted.

f. Gasket: Spiral Wound, Graphite Filler.

2. Sizes 3" - 6":

a. Class: 150 PSI, 150 Raised Face Flanged.

b. Type: Ball Check.

c. Body: 316 Stainless Steel ASTM A 351.

d.	Ball:	316 Stainless Steel ASTM A 351.
c.	Trim:	316 Stainless Steel.
d.	Bonnet:	Bolted.
e.	Gasket:	Spiral Wound, Graphite Filler.

3. Sizes 3" - 24":

a.	Class:	150 PSI.
b.	Type:	Wafer, Dual Flapper.
c.	Body:	316 Stainless Steel ASTM A351.
d.	Trim:	316 Stainless Steel.
e.	Seal:	Viton or PTFE.
f.	Gasket:	Spiral Wound, Graphite Filler.

F. Knife Gate Valves:

1. Sizes 2" - 18":

a.	Class:	150 PSI, 150 Raised Face.
b.	Type:	Wafer Style
c.	Body and Knife:	316 Stainless Steel.
d.	Stem & Yoke:	316 Stainless Steel.
e.	Seat:	316 Stainless Steel, Metal to Metal.
f.	Connector:	316 Stainless Steel.
g.	Packing:	PTFE.
h.	Operator:	Manual, Worm gear with handwheel.

G. Plug Valves:

1. Sizes 1/2" – 2 1/2":

a.	Class:	600 PSI, Socket weld.
b.	Type:	Lubricated Plug.
c.	Body:	316 Stainless Steel ASTM A 351.
d.	Plug:	316 Stainless Steel ASTM A 351.
e.	Cover:	Bolted.
f.	Gasket:	Manufacturer's Standard.
g.	Operator:	Manual, Lever.

2. Sizes 3" - 4":

a.	Class:	150 PSI, 150 Raised Face Flanged.
b.	Type:	Lubricated Plug.
c.	Body:	316 Stainless Steel ASTM A 351.
d.	Plug:	316 Stainless Steel ASTM A 351.
e.	Cover:	Bolted.
f.	Gasket:	Manufacturer's Standard.
g.	Operator:	Manual, Lever.

2.06 NSF / ANSI STANDARD 61

Piping, fittings, and appurtenances in contact with potable water or water that will be treated to become potable shall be listed in NSF / ANSI Standard 61 as being suitable for contact with potable water.

PART 3 - EXECUTION

3.01 GENERAL

A. All laying, jointing, testing for defects and for leakage shall be performed in the presence of the Engineer, and shall be subject to his approval before acceptance. All material found during the progress to have defects will be rejected and the Contractor shall promptly remove such defective materials from the site of the Work.

3.02 HANDLING AND STORAGE

A. Handling: All pipes, fittings, flanges, valves and accessories shall be carefully inspected before and after installation and those found defective shall be rejected. Pipe and fittings shall be free from fins and burrs. Before being placed in position, pipe, fittings, and accessories shall be cleaned, and shall be maintained in a clean condition. Proper

facilities shall be provided for lowering sections of pipe into trenches. Under no circumstances shall pipe, fittings or any other material be dropped or dumped into trenches.

B. Storage: All pipes, fittings, flanges, valves and accessories should be stored, if possible, at the job site in unit packages provided by the manufacturer. Caution should be exercised to avoid compression damage or deformation to piping. Gaskets should be stored in a cool, dark place out of the direct rays of the sun, preferably in original cartons.

3.03 TRENCHING AND BACKFILL

A. Trench excavation and backfill shall be as illustrated in the Plans and as specified herein. The minimum backfill compaction in the pipe zone shall be 90 percent of maximum density per ASTM D 1557.

3.04 PIPING INSTALLATION AND JOINTS

A. All piping and appurtenances shall be installed in accordance with the manufacturer's requirements and all applicable and related Divisions of these Specifications.

B. Pipe shall be supported at its proper elevation and grade, care being taken to secure firm and uniform support. Wood support blocking will not be permitted. The full length of each section of pipe and fittings shall rest solidly on the pipe bed, with recessed excavation to accommodate bells, joints, and couplings. Anchors and supports shall be provided where necessary and where indicated on the Plans for fastening work into place. Fittings shall be independently supported.

C. Welding shall conform to these specifications and the requirements contained in ASME B 31.1, Power Piping, as last revised.

END OF SECTION 15740

3.05 CLEANING AND FINISHING

A. The interior of all pipe and fittings shall be thoroughly cleaned of all foreign matter prior to installation, and shall be kept clean until the work has been accepted.

B. Before jointing, all joint contact surfaces shall be wire brushed, wiped clean, and kept clean until the jointing is completed.

C. Flange faces shall be wire brushed and cleaned to remove all oil, grease, loose primer, mill scale, or any other foreign matter which could affect the proper seating of the gasket.

D. Cleaning of weld joints and weld joint areas of stainless steel piping system, both before and after welding, shall conform to ASTM A 380. Use only stainless steel brushes or stainless steel wool.

E. Finishing: Following fabrication of stainless steel piping connections, all weld areas shall be pickled to remove all mill scale, weld inclusions, and color, and passivated inside and out in conformance to ASTM A 380.

F. Contractor shall submit the cleaning and passivation procedure of stainless steel piping system in compliance with the above requirements for Engineer's review and approval.

3.06 FIELD TESTING AND DISINFECTION

A. Field testing and disinfection of fresh or potable water pipe installations shall conform to AWWA Standards and NSF 61 Standards.

3.07 PIPE SUPPORTS

A. All pipes shall be adequately supported.

3.08 PROTECTIVE COATING

A. Protective coating for piping systems shall be provided in accordance with the requirements of Section 09800 - Protective Coatings.

END OF SECTION 15740

SECTION 15830 - MISCELLANEOUS VALVES

PART 1 - GENERAL

1.01 DESCRIPTION

A. The Contractor shall furnish and install miscellaneous valves as shown and as specified herein, complete and operable including accessories and, where designated, operators, in accordance with the requirements of the Contract Documents.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Division 2 - Sitework.

B. Section 11000 – Equipment General Provisions.

C. Division 15 - Mechanical.

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Comply with the reference specifications of the General Requirements.

B. NSF / ANSI STANDARD 61: Piping, fittings, and appurtenances in contact with potable water or water that will be treated to become potable shall be listed in NSF / ANSI Standard 61 as being suitable for contact with potable water.

1.04 CONTRACTOR SUBMITTALS

A. Submittals shall be made in accordance with Section 01300 - Contractor Submittals.

1.05 QUALITY ASSURANCE

A. QUALITY ASSURANCE shall comply with the quality requirements specified in RELATED WORK SPECIFIED ELSEWHERE above.

B. All valves shall be tested in accordance with manufacturer's recommendation and applicable AWWA/ANSI specifications

PART 2 - PRODUCTS

2.01 COMBINATION AIR-VACUUM VALVES

A. Combination Air and Vacuum Valves: Combination air valves shall combine the characteristics of air and vacuum valves and air release valves by exhausting accumulated air in systems under pressure and releasing or re-admitting large quantities of air while a system is being filled or drained, respectively. They shall be of the size shown, with flanged or screwed ends to match piping. Bodies, the float, seat, and all moving parts shall be constructed of Type 316 stainless steel. Seat washers and gaskets shall be of a material insuring water tightness with a minimum of maintenance. Valves shall be designed for minimum 150 PSI water-working pressure, unless otherwise shown.

2.02 BACKFLOW PREVENTER VALVES

A. General: Backflow preventers shall work on the reduced pressure principle. They shall consist of two (2) spring-loaded check valves, automatic differential pressure relief valve,

drain valves, and shut-off valves. The body material shall be bronze or cast iron for a working pressure of not less than 150 PSI, with bronze or stainless steel trim. Drain lines with air gaps shall be provided.

B. Manufacturers, or Equal:

1. Model: 4000B
AMES Fire & Waterworks
1427 North Market Boulevard, Suite #9
Sacramento, CA 95854
916-928-0123
916-928-9333: FAX

2. Model: 850V
FEBCO
4381 North Brawley, Suite 102
Fresno, CA 93722
559-441-5300
559-441-5301: FAX

3. Or Equal.

2.03 SMALL PRESSURE REDUCING VALVES (Air, Chemical and Water Systems)

A. General: Small air and water pressure reducing valves shall be of the spring-loaded diaphragm type with a minimum pressure rating of 250 PSI, with bronze body, nickel alloy or stainless steel seat, and threaded ends. Each valve shall be furnished with built-in or separate strainer and union ends.

B. Small chemical (i.e. ammonium hydroxide, sodium bisulfite, and sodium hypochlorite) pressure reducing valves shall be of the spring-loaded diaphragm type with Teflon body, hastelloy or Teflon trim material, and Teflon seat material. Value body shall be flanged.

2.04 LARGE WATER PRESSURE REDUCING VALVES

A. General: Large water pressure reducing valves shall be of the piston-type or diaphragm-actuated globe type, with cast iron body and stainless steel trim. Unless otherwise shown or specified, the valves shall have a pressure rating of not less than 150 PSI, shall have 125 lb flanges, and shall have an adjustable downstream pressure range with a downstream setting as required.

2.05 PRESSURE RELIEF VALVES

A. Pressure Relief Valves for chemical piping systems shall be in-line pattern with three ports. Excess pressure shall be relieved through the port in the bottom of the valve. The valve materials shall be as described in Table 2.1. For the diaphragm material, Teflon or other suitable material may be substituted for EPDM.

TABLE 2-1 RELIEF VALVE MATERIALS FOR CHEMICAL SYSTEMS

	Systems

ITEM	Ammonium Hydroxide	Scale Inhibitor	Sodium Bisulfite	Polymer	Sodium Hypochlorite	Sulfuric Acid
Relief Valves (Body) (Diaphragm)	PVC or Teflon EPDM	PVC EPDM	PVC or Teflon EPDM	PVC or Teflon Teflon	PVC or Teflon Teflon	PVDF or Teflon Teflon

2.06 CORPORATION STOPS

A. Unless otherwise shown, corporation stops shall be made of solid brass for key operation, with screwed ends with corporation thread or iron pipe thread, as required.

B. Manufacturer, or Equal:

1. James Jones.

2. Mueller.

3. Or equal.

2.07 SOLENOID VALVES

A. Solenoid valves shall be of the size, type, and class shown and shall be designed for not less than 150 PSI water-working pressure. Valves for water, air, or gas service shall have brass or bronze body with screwed ends, stainless steel trim and spring, Teflon or other resilient seals with material best suited for the temperature and fluid handled. Solenoid valves in corrosive environment shall have stainless steel bodies. For chemicals and all corrosive fluids, solenoid valves with Teflon bodies and springs or other suitable materials shall be used. General purpose enclosures for indoors shall be NEMA type 2. For explosion proof, corrosive, special purpose, or outdoor locations NEMA type 4, 7, 8, 9, 9E, 9F, or 9G enclosures shall be used, as applicable. All coil ratings shall be for continuous duty. For electrical characteristics see electrical drawings or specifications.

2.08 STAINLESS STEEL VALVES

A. General:

1. All valves shall be furnished and installed as illustrated on the Plans.

2. Valves with pneumatic, hydraulic, and electric motor operators and controls shall be in accordance with Division 17.

B. Fasteners: All bolts, nuts, and washers shall be made of Type 316 stainless steel.

C. Ball Valves:

1. Sizes 1/2" - 2 1/2":

a. Class: 900 PSI, Screwed.
b. Type: Full port.
c. Body: 316 Stainless Steel ASTM A 351.
d. Ball: 316 Stainless Steel.

e. Seat: Reinforced PTFE Fire Safe.
f. Stem: 316 Stainless Steel.
g. Operator: Manual, Lever.

2.10 WELL SERVICE AIR VALVE

The well service air valves shall be fully automatic float operated valves designed to exhaust air which is present in the pump column on pump startup and allow air to re-enter the column on pump shutdown or should a negative pressure occur. The dual port throttling device shall provide adjustable control of the exhaust rate and allow free flow into the valve through a separate inlet port.

The valves shall be manufactured and tested in accordance with AWWA Standard C512. The manufacturer shall have a quality management system that is certified to ISO 9001 by and accredited, certifying body. The valves shall have full size NPT inlets and outlets equal to the nominal valve size. The body inlet connection shall be hexagonal for a wrench connection. The valves shall have two additional NPT connections for the addition of Air Release Valves, gauges, testing and draining.

The valve body shall provide a through flow area equal to the nominal valve size. A bolted cover with alloy screws and flat gasket shall be provided to allow for maintenance and repair. Floats shall be unconditionally guaranteed against failure including pressure surges. The float shall have a hexagonal guide shaft supported in the body by circular bushings to prevent binding from debris. The float shall be protected against direct water impact by an internal baffle. The resilient seat shall provide drop tight shut off to the full valve pressure rating.

Valves 3 inches (75mm) and smaller will be equipped with a *dual port throttling device* to control the discharge of air from the valve and allow full vacuum flow through a separate port. The device shall have an externally adjustable screw and locknut for adjusting the discharge control disc. The disc shall be sized to allow a 5% flow area when fully throttled. The vacuum port shall be equipped with a spring-loaded disc to allow flow into the valve during negative pressure conditions. Throttling devices with a common exhaust and vacuum port are not acceptable. The material of the body shall be consistent with the Well Service Air Valve. The spring shall be ASTM A313 Type 316 SS. The dual port throttling device shall be mounted on the inlet of the well service air valve to allow free air flow in and restricted flow out of the valve to reduce valve pressure surges. The device shall be a flanged, globe pattern, with a center guided disc and seat assembly. The disc shall have threaded holes to provide adjustment of the flow rate through the valve. The material of the body shall be consistent with the well service air valve. The seat and disc shall be Bronze ASTM B584, alloy C83600.

The well service air valve body, cover and baffle shall be constructed of ASTM A126 Class B cast iron for Class 125 valves. The float, guide shafts and bushings shall be constructed of Type 316 SS. Non-metallic guides and bushings are not acceptable. Resilient seats shall be Buna-N. The valve interior shall be coated with an NSF/ANSI 61 certified fusion bonded epoxy in accordance with AWWA C550. The exterior of the valve shall be coated with a universal alkyd primer. The valve manufacturer shall provide test certificates, dimensional drawings, part list drawings and operation and maintenance manuals.

2.10 NSF / ANSI STANDARD 61

Piping, fittings, and appurtenances in contact with potable water or water that will be treated to become potable shall be listed in NSF / ANSI Standard 61 as being suitable for contact with potable water.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Backflow preventers shall be installed in all potable water lines and as illustrated in the Plans.

B. All valves shall be installed in accordance with the Manufacturer's printed recommendations.

C. Field testing of valves shall be performed in accordance with manufacturer's recommendations.

D. All field testing shall be witnessed and approved by the Engineer.

END OF SECTION 15830